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-
Mediterranean assessments 2016- part 2 (STECF-17-06)

Edited by John Simmonds, Giacomo Chato Osio and Alessandro Mannini

This report was reviewed by the STECF during its 54th plenary meeting held from 27 to 31 March 2017 at JRC, Ispra, Italy.

Joint Research Centre

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Contact information
Name: STECF secretariat
Address: Unit D.02 Water and Marine Resources, Via Enrico Fermi 2749, 21027 Ispra VA, Italy
E-mail: stecf-secretariat@jrc.ec.europa.eu
Tel.: +39 0332 789343

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Abstract
Commission Decision of 25 February 2016 setting up a Scientific, Technical and Economic Committee for Fisheries, C(2016) 1084, OJ C 74, 26.2.2016, p. 4–10. The Commission may consult the group on any matter relating to marine and fisheries biology, fishing gear technology, fisheries economics, fisheries governance, ecosystem effects of fisheries, aquaculture or similar disciplines. The Expert Working Group meeting of the Scientific, Technical and Economic Committee for Fisheries EWG 16-17 was held from 19 Nov-25 Nov 2016 in Ispra, Italy to assess the status of demersal and small pelagic stocks in the Mediterranean Sea against the proposed FMSY reference points. Thehe report was reviewed by the STECF plenary in March 2017.

Authors:

STECF advice:

Ulrich, C., Abella, J. A., Andersen, J., Arrizabalaga, H., Bailey, N., Bertignac, M., Borges, L., Cardinale, M., Catchpole, T., Curtis, H., Daskalov, G., Döring, R., Gascuel, D., Lloret, J., Knittweis, L., Malvarosa, L., Martin, P., Motova, A., Murua, H., Nord, J., Prellezo, R., Raid, T., Sabatella, E., Sala, A., Scarcella, G., Soldo, A., Somarakis, S., Stransky, C., van Hoof, L., Vanhee, W., Van Oostanbrugge, H., Vrgoc, Nedo.

EWG-16-17 report:

Simmonds, E. J., A., Abella, J.A., Cikes Kec, V., Colloca, F., Facchini, M.T., Kokkalis, A., Mannini, A., Martin, P., Musumeci, C., Murenu, M., Ordinas, F., Osio, G. C., Ramirez, J., Recasens, L., Rodriguez, M.G., Sbrana, M., Scott, F., Vasilakopoulos, P., Zorica, B.

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SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES (STECF) - Mediterranean assessments 2016 - part 2 (STECF-17-06)

Request to the STECF

STECF is requested to review the report of the STECF Expert Working Group meeting, 16-17 evaluate the findings and make any appropriate comments and recommendations.

STECF response

STECF observations

The working group was held in Ispra, Italy, from 19th to 25th November 2016. The meeting was attended by 19 experts in total, including 2 STECF members and 3 JRC experts.

The objective of the EWG 16-17 was the stock assessment of demersal species. The ToRs were based on the STECF-EWG16-14 (Methodology for the stock assessments in the Mediterranean Sea) report, where stocks were classified into levels according to the available information and stock assessments methods were proposed to determine stock status (https://stecf.jrc.ec.europa.eu/documents/43805/1446742/2016-07_STECF+16-14Methods+for+MED+stock+assessments_JRC102680.pdf).

STECF acknowledges that compared to the previous Mediterranean meeting (STECF-EWG16-13) EWG16-17 had two additional days to answer the ToRs. STECF notes that this additional time was of considerable help, allowing a full review of the work and agreement on conclusions during the meeting.

TERMS OF REFERENCE:

For the stocks given in Annex I, the STECF-EWG16-17 is requested to:

ToR 1. Data gathering

1.1. Compile and provide the most updated information on stock identification, age and growth, maturity, feeding, habitat, and natural mortality.

1.2. Compile and provide complete sets of annual data on landings and discards for the longest time series available up to and including 2015. This should be presented by fishing gear as well as by size/age structure (see Annex II for more details).

1.3. Compile and provide complete sets of annual data on fishing effort for the longest time series available up to and including 2015. This should be described in terms of amount of vessels, time (days at sea, soaking time, or other relevant parameter) and fishing power (gear size, boat size, horse power, etc.) by Member State and fishing gear. Data shall be the most detailed possible to support the establishment of a fishing effort or capacity baseline (see Annex II for more details).

1.4. Compile and provide indices of abundances and biomass by year and size/age structure for the longest time series available up to and including 2015 (see Annex II for more details).

ToR 2. Stock assessments (Level 1)

2.1. Assess trends in fishing mortality, stock biomass, spawning stock biomass, and recruitment. Different assessment models should be applied as appropriate. Models should be compared using model diagnostics including retrospective analyses when the models can produce one. The selection of the most reliable assessment should be justified. Assumptions and uncertainties should be reported.

2.2. Propose and evaluate candidate MSY value, range of values and safeguard points in terms of fishing mortality and stock biomass. The proposed values shall be related to long-term high yields and low risk of stock/fishery collapse and ensure that the exploitation levels restore and maintain marine biological resources at least at levels which can produce the maximum sustainable yield.

2.3. Provide short and medium1 term forecasts of spawning stock biomass, stock biomass and catches. The forecasts shall include different management scenarios, *inter alia*: zero catch, the status quo fishing mortality, and target to F_{MSY} or other appropriate proxy by 2018 and 2020 (by means of a proportional reduction of fishing mortality as from 2017). In particular, predict the level of fishing effort exerted by the different fleets which is commensurate with the short- and medium-term forecasts of the proposed scenarios.

2.4. Make any appropriate comments and recommendations to improve the quality of the assessments. Furthermore, advise on the ideal assessment frequency.

ToR 3. Stock assessments (Levels 2-4)

3.1. Assess trends in fishing mortality, stock biomass, spawning stock biomass, and recruitment. Based on the precautionary approach, determine proxies MSY reference points on the exploitation level and the status of the stocks. Different assessment models should be applied as appropriate, including retrospective analyses when the models can produce one. The selection of the most reliable assessment should be explained. Assumptions and uncertainties should be specified.

3.2. Make any appropriate comments and recommendations to improve the quality of the assessment and/or to upgrade the assessment level and/or improve the quality of the data. Furthermore, advise on the ideal assessment frequency.

ToR 4. Summary sheets

[1] Medium term forecast only when an acceptable stock-recruitment relationship is identifiable.

Provide a synoptic overview of: (i) the fishery; (ii) the most recent state of the stock (spawning stock biomass, stock biomass, recruits, and exploitation level by fishing gear); (iii) the source of data and methods and; (iv) the management advice, including MSY value or proxies, range of values and safeguard points.

ToR 5. Data quality check

Summarize and concisely describe all data quality deficiencies, including possible limitations with the surveys of relevance for stock assessments and fisheries. Such review and description are to be based on the data format of the official DCF data call for the Mediterranean Sea launched on the 28 April 2016. Identify further research studies and data collections which would be required for improved fish stock assessments.

STECF comments

STECF considers that the EWG successfully addressed all the ToRs. STECF notes that the EWG carefully reviewed the quality of the assessments produced. Some analyses were considered to be suitable for short term forecasts, others were only considered sufficiently reliable to estimate F-status, but no forecast was produced; and one assessment was judged to be too unreliable to determining stock status or to provide advice.

The report summarises the available data for each area/species combination; assessment or index analyses and catch options whenever suitable. Where possible, stock status and catch estimates are provided, as well as a short term forecast in terms of changes in F. The EWG carried out seven age-based analytical assessments with short term forecasts, F target and catch estimates for 2017.

STECF discussed the methodological approaches used by the EWG. Age-based approaches may not be the most suitable for shellfish for which direct age assignation is not possible and environmental forces may produce important changes in biological parameters such as growth over time. More advanced length-based methods now exist and are used for other shellfish stocks in the world. STECF notes that such methods could be explored in the future for Mediterranean shellfish stocks as well. STECF also acknowledges that the short time series of data for all these stocks results in some instability in the estimates, although such uncertainty is considered acceptable. When additional data become available some revision to the results and methods used will be performed. STECF considers nevertheless, that these current assessments are of a sufficient standard to be used as the basis for catch / fishing mortality estimates.

STECF agrees with the EWG statement that the time series of age based information for all stocks were too short and not enough contrasting to allow the evaluations of fishing mortality (F) reference points based on a reliable stock-recruitment relationship. Comparisons between current F and target Fs were based on the F_{MSY} proxy $F_{0.1}$ derived from yield per recruit (Y/R) analyses.

STECF notes that the EWG provided estimates for *Nephrops* in GSAs 17-18 combined, based on a long time series of catch and a surplus production model. The results show a relatively poor retrospective performance in estimation of F, while retrospectives on Biomass are less problematic. In any case, all retrospective runs fall inside the uncertainty regions.

STECF also notes some uncertainty catches from the early part of the time series, but when testing the results with and without early historic catches the conclusions on stock status did not change. So the method is considered sufficiently robust to these issues and informative of stock status. STECF notes that the biomass of *Nephrops* in GSA 17-18 is estimated to be at $0.38B_{msy}$ (Table XX), close to the lowest observed of the time series. . The short term forecast carried out suggest that reducing fishing mortality at $F=F_{MSY}$ in 2017 and beyond are expected to lead to a slow increase in biomass, recovering to B_{MSY} in around 8 years . The forecast suggests that catches corresponding to F=Fmsy in 2017 could be slightly higher than in 2015 (+8%), but still substantially below the catches observed up to 2014.

STECF notes that in future, the EWG and GFCM are expected to continue to attempt to produce age or length-based assessments for this stock using multiple growth models that incorporate regional and sexual differences in growth, as referred to in EWG-16-17. Until then, STECF endorses the use of the surplus production approach for this stock and the main resulting conclusions. EWG noted that, in common with many assessment models, the model is sensitive to the choice of tuning series. STECF agrees with the EWG that the longest time series which used the maximum catch information and providing the narrowest confidence intervals resulted as the appropriate choice in this case.

STECF observes that there are some additional considerations for this stock. The spatial boundaries and the stock definition remain unclear. The specific project (STOCKMED) aimed at the definition of stocks units in the Mediterranean was not conclusive, especially for this area, due to a generalized lack of evidence on some aspects useful for stock discrimination as larval dispersal, connectivity, genetics, and also in detailed fisheries activities as spatial distribution of the fleets. Nevertheless, there was observed spatial variability in growth among *Nephrops* in GSA 17 and GSA 18, especially in the deep waters of the Pomo Pit.. Secondly, the possible underestimation of the catch in the early part of the time series.might overestimate SSB_{2016} Therefore to take a precautionary approach and deliver F_{MSY} in 2017, compared to the estimated F_{2015}, fishing mortality would need to be reduced to at least the 23% reduction indicated in the forecast table (Table 4.3.1).

Regarding the other *Nephrops* stocks, STECF considers the *Nephrops* XSA assessments (for GSA 9 and 11) give reliable results, based on the evaluation of residuals and retrospective performance. STECF notes that some issues associated with MEDITS data from 2011 in GSA 11 do not strongly affect the assessment results and associated catch estimates. Underwater TV survey observations are not available for these stocks.

STECF acknowledges the attempt to obtain a fully converged age based assessment for *Nephrops* in GSA 6. STECF agrees with the EWG that the XSA model gives rise to concern due to either methodological or more likely data issues for the MEDITS surveys. STECF endorses the general EWG conclusion that F in 2013 is above $F_{0.1}$ by a factor of about 4 and that all the evidences suggest a further increasing in F in 2014 and 2015. STECF therefore supports the EWG conclusions that F should be reduced.

STECF notes that the all four deep-water rose shrimp assessments (GSAs 1, 9, 10 separately and 9, 10 &11 combined) give robust results with only minor retrospective revision and can be considered useful for catch estimates. STECF notes that assessment of deep-water rose shrimp in GSA 9 was undertaken by the GFCM in 2016 and was adopted unchanged by the EWG. The combined assessment of deep-water rose shrimp in GSAs 9, 10 and 11 shows a stock with exploitation close to MSY, and STECF considers the assessment provided for the whole area representative of the overall status at this wide scale. However, the comparison of the assessment performed on the combined area with the assessments performed in the single GSA might indicate that exploitation rates could be higher in GSA 10 than in GSA 9 and 11. However, neither in this case, evidences of eggs and larvae dispersal necessary for assuming connectivity and supporting fusion are not available even though hypothesized.

STECF notes that the assessment for striped red mullet (GSA 9) using 6 age groups shows a slightly poorer retrospective performance than an alternative assessment based on 4 ages only. STECF supports the EWG conclusions that the 4+ assessment is of sufficient reliability to be used for catch forecast.

STECF also agrees with the EWG that considered not feasible to carry out analytical age based assessments for anglerfish, seabass, (GSAs 1, 5, 6, 7) sole and gilthead seabream (GSA 7). STECF endorses the use of the VIT model as an alternative. This method produces results which reliability and precision are limited as is based on a limited number of years and include strong assumptions as equilibrium status. It cannot estimate annual recruitment, and is not suited to assessing trends in F or SSB . However, STECF recognises that the model can supply a preliminary perception of the stocks status. In these cases variability in estimated parameters across years was small suggesting the values of F and $F_{0.1}$ are relatively stable and suitable for advice. STECF also agrees with the EWG warning that this method can be considered suitable for F estimates in these specific cases but not for short-term forecasts or precautionary biomass evaluations. For these assessments the precision of F values presented in the table below have been truncated to one digit of precision, to retain information of the general magnitude of the $F/F_{0.1}$ ratio, but to bring out the lower precision of these evaluations relative to the age base assessments.

Finally STECF supports the view of the EWG that stock status could not be provided for a number of stock units: -striped red mullet in GSA 11; European seabass in the combination of GSAs 1, 5, 6 & 7; and anglerfish in GSA 6 and GSA 7 separately due to data deficiencies. In the cases of anglerfish and seabass assessments are provided for GSA 1,5,6&7 combined and GSA 7 respectively. STECF also notes that the estimate of F for common sole in GSA 7 can only be indicative of the direction of change required to reach $F_{0.1}$ and the magnitude of the changes cannot be reliably identified. STECF would encourage the Commission to try to obtain more comprehensive data, particularly from Italy for GSA 11 and especially from France for GSA 7.

In addition STECF notes that for a number of species, alternative and potentially more efficient spatial scales of aggregation useful for management purposes should be evaluated based on clear evidence (genetics, fishery activity, connectivity, etc.).

STECF encourages the use of information derived from other sources (research projects, monitoring of MPAs), especially for coastal species for which an important part of the catch (particularly spawners) is made by artisanal (small-scale) or recreational fisheries in EU Mediterranean waters). The shallower portion of the coastal area is not covered by the routinely carried out trawl and echo-surveys.

The basis of all the evaluations discussed above are dependent on the type and quality of information available. The tables provided in Section 2 and Section 5 of the EWG report and summarized below show the assessment work that was attempted, and the basis for stock status and values of F and where possible catch at F_{MSY} that have been estimated for each stock.

STECF conclusions

STECF acknowledges that the EWG was able to address all the terms of reference, completing evaluations of all GSA/species combinations requested. However, due to shortage of data a full assessment of some stocks in certain areas or combinations of stock areas was not possible.

STECF concludes that the accepted assessment in Table XX below and the summary sheets in section 5 of the report provides the best information currently available on the status of the stocks and the trends in stock biomass and fishing mortality for the stocks concerned.

Finally, STECF noticed that in some cases assessments conducted at Med EWG remain different from those made at GFCM. This remains a point of concern considering that assessments are often used for giving quantitative advice on future fishing opportunities. The current efforts made by DGMare and GFCM to improve the quality and availability of assessment results contribute to improving the situation and should be sustained.

Table 1. Summary of results from EWG 16-17 by area and species, showing F in 2015, target F under exploitation at Fmsy proxy (=$F_{0.1}$ for all stocks except for *Nephrops* 17-18 where an estimate of Fmsy is available) and the resulting catch, change in catch and change in predicted change in SSB from 2015 to 2018. F_{2015} is terminal F in the assessment. Change in F is the difference (expressed as a fraction " Fmultiplier" and in %) between Fmsy proxy and the estimated F in 2015. The change in is from recent $catch_{2015}$ to based on Fmsy proxy in 2017 $catch_{2017}$ expressed as $Catch_{2017}/Catch_{2015}$ -1 (in %). Recent biomass status is given relative to B_{MSY} where available, (*Nephrops* in 17&18 only) and as an indication of trend over the last 3 years for stocks with time series analytical assessments. $Biomass_{2018}$/ $Biomass_{2015}$ expresses the predicted change in biomass if fishing is carried out at the specified Fmsy proxy (expressed in ratio and in %)

Species	Area	Method / basis	F_{2015}	F_{MSY} Proxy	Fmult = $F_{MSY}/F_{status\ quo}$	Catch 2015	Catch 2017 (MSY)	$Catch_{2017}$ / $Catch_{2015}$ -1	Recent Biomass	$Biomass_{2018}$/ $Biomass_{2015}$
European seabass	GSA 7	VIT	3*$F_{0.1}$	0.14	0.3 (-70%)	-	-	-		
European seabass	GSA 1-5-6-7	No advice	-	-	-	-	-	-		
Anglerfish	GSA 6	No advice	-	-	-	-	-	-		
Anglerfish	GSA 7	No advice	-	-	-	-	-	-		
Anglerfish	GSA 1-5-6-7	VIT	3*$F_{0.1}$	0.2	0.3 (-70%)	-	-	-		
Striped red	GSA 9	XSA, STF	0.49	0.52	1.06	260	313	+20%	Declinin	1.23

mullet					(+6%)				g	(+23%)
Striped red mullet	GSA 11	No advice	-	-	-	-	-	-		
Norway lobster	GSA 6	SepVPA,	>4*$F_{0.1}$	0.175	<0.25 (-75%)	-	-	-	Declining	
Norway lobster	GSA 9	XSA,	0.34	0.19	0.56 (-44%)	114	83	-27%	stable	1.53 (+53%)
Norway lobster	GSA 11	XSA,	0.39	0.19	0.49 (-51%)	18.2	8.3	-54%	Stable	0.96 (-4%)
Norway lobster	GSA 17-18	SPiCT	0.48	0.38	0.77 (-23%)	1185	1288	+ 8%	38%B_{MSY}	1.63 (+63%)
Deep-water rose shrimp	GSA 1	XSA, STF	0.78	0.87	1.1 (+10%)	114	138	21%	Declining	1.78 (+78%)
Deep-water rose shrimp	GSA 9-10-11	XSA, STF	0.87	0.91	1.0	1536	1585	3%	Stable	0.92 (0-8%)
Common sole	GSA 7	VIT	Reduce F			-	-	-		
Gilthead seabream	GSA 7	VIT	2*F0.1	0.2	0.5 (-50%)	-	-	-		

Contact details of STECF members

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Name	**Address**[1]	**Tel.**	Email
STECF members			
Abella, J. Alvaro	Independent consultant	Tel. 0039-3384989821	aabellafisheries@gmail.com

Name	Address[1]	Tel.	Email
STECF members			
Andersen, Jesper Levring	Department of Food and Resource Economics (IFRO) Section for Environment and Natural Resources University of Copenhagen Rolighedsvej 25 1958 Frederiksberg Denmark	Tel.dir.: +45 35 33 68 92	jla@ifro.ku.dk
Arrizabalaga, Haritz	AZTI / Unidad de Investigación Marina, Herrera kaia portualdea z/g 20110 Pasaia (Gipuzkoa), Spain	Tel.: +34667174477	harri@azti.es
Bailey, Nicholas	Marine Scotland Science, Marine Laboratory, P.O Box 101 375 Victoria Road, Torry Aberdeen AB11 9DB UK	Tel: +44 (0)1224 876544 Direct: +44 (0)1224 295398 Fax: +44 (0)1224 295511	baileyn@marlab.ac.uk n.bailey@marlab.ac.uk
Bertignac, Michel	Laboratoire de Biologie Halieutique IFREMER Centre de Brest BP 70 - 29280 Plouzane, France	tel : +33 (0)2 98 22 45 25 - fax : +33 (0)2 98 22 46 53	michel.bertignac@ifremer.fr
Borges, Lisa	FishFix, Brussels, Belgium		info@fishfix.eu
Cardinale, Massimiliano (vice-chair)	Föreningsgatan 45, 330 Lysekil, Sweden	Tel: +46 523 18750	massimiliano.cardinale@slu.se
Catchpole, Thomas	CEFAS Lowestoft Laboratory, Pakefield Road, Lowestoft Suffolk, UK NR33 0HT		thomas.catchpole@cefas.co.uk
Curtis, Hazel	Sea Fish Industry Authority 18 Logie Mill Logie Green Road Edinburgh EH7 4HS, U.K.	Tel: +44 (0)131 524 8664 Fax: +44 (0)131 558 1442	Hazel.curtis@seafish.co.uk
Daskalov, Georgi	Laboratory of Marine Ecology, Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences	Tel.: +359 52 646892	Georgi.daskalov@gmail.com
Döring, Ralf (vice-chair)	Johann Heinrich von Thünen Bundesforschungsinstitut, für Ländliche Räume, Wald und Fischerei, Institut für Seefischerei - AG Fischereiökonomie, Palmaille 9, D-22767 Hamburg, Germany	Tel.: 040 38905-185 Fax.: 040 38905-263	ralf.doering@thuenen.de

Name	Address[1]	Tel.	Email
STECF members			
Gascuel, Didier	AGROCAMPUS OUEST 65 Route de Saint Brieuc, CS 84215, F-35042 RENNES Cedex France	Tel:+33(0)2.23.48.5 5.34 Fax: +33(0)2.23.48.55.35	Didier.Gascuel@agrocampus-ouest.fr
Lloret, Josep	Associate Professor (Professor Agregat), University of Girona (UdG), Spain		josep.lloret@udg.edu
Knittweis, Leyla	Department of Biology University of Malta Msida, MSD 2080 Malta		Leyla.knittweis@um.edu.mt
Malvarosa, Loretta	NISEA S.c.a.r.l.		malvarosa@nisea.eu
Martin, Paloma	CSIC Instituto de Ciencias del Mar Passeig Marítim, 37-49 08003 Barcelona Spain	Tel: 4.93.2309500 Fax: 34.93.2309555	paloma@icm.csic.es
Motova, Arina	Sea Fish Industry Authority 18 Logie Mill Logie Green Road Edinburgh EH7 4HS, U.K	Tel.: +44 131 524 8662	arina.motova@seafish.co.uk
Murua, Hilario	AZTI / Unidad de Investigación Marina, Herrera kaia portualdea z/g 20110 Pasaia (Gipuzkoa), Spain	Tel: 0034 667174433 Fax: 94 6572555	hmurua@azti.es
Nord, Jenny	The Swedish Agency of Marine and Water Management (SwAM)	Tel. 0046 76 140 140 3	Jenny.nord@havochvatten.se
Prellezo, Raúl	AZTI -Unidad de Investigación Marina Txatxarramendi Ugartea z/g 48395 Sukarrieta (Bizkaia), Spain	Tel: +34 667174368	rprellezo@azti.es
Raid, Tiit	Estonian Marine Institute, University of Tartu, Mäealuse 14, Tallin, EE-126, Estonia	Tel.: +372 58339340 Fax: +372 6718900	Tiit.raid@gmail.com
Sabatella, Evelina Carmen	NISEA, Via Irno, 11, 84135 Salerno, Italy	TEL.: +39 089795775	e.sabatella@nisea.eu
Sala, Antonello	Italian National Research Council (CNR) Institute of Marine Sciences (ISMAR), Largo Fiera della Pesca, 1 60125 Ancona - Italy	Tel: +39 071 2078841 Fax: +39 071 55313 Mob.: +39 3283070446	a.sala@ismar.cnr.it

Name	Address[1]	Tel.	Email
STECF members			
Scarcella, Giuseppe	1) Italian National Research Council (CNR), Institute of Marine Sciences (ISMAR) - Fisheries Section, Largo Fiera della Pesca, 1, 60125 Ancona – Italy 2) AP Marine Environmental Consultancy Ltd, 2, ACROPOLEOS ST. AGLANJIA, P.O.BOX 26728 1647 Nicosia, Cyprus	Tel: +39 071 2078846 Fax: +39 071 55313 Tel.: +357 99664694	g.scarcella@ismar.cnr.it gscarcella@apmarine.com.cy
Soldo, Alen	Department of Marine Studies, University of Split, Livanjska 5, 21000 Split, Croatia	Tel.: +385914433906	soldo@unist.hr
Somarakis, Stylianos	Institute of Marine Biological Resources and Inland Waters (IMBRIW), Hellenic Centre of Marine Research (HCMR), Thalassocosmos Gournes, P.O. Box 2214, Heraklion 71003, Crete, Greece	Tel.: +30 2810 337832 Fax +30 6936566764	somarak@hcmr. gr
Stransky, Christoph	Thünen Institute [TI-SF] Federal Research Institute for Rural Areas, Forestry and Fisheries, Institute of Sea Fisheries, Palmaille 9, D-22767 Hamburg, Germany	Tel. +49 40 38905-228 Fax: +49 40 38905-263	christoph.stransky@thuenen.de
Ulrich, Clara (chair)	Technical University of Denmark, National Institute of Aquatic Resources, (DTU Aqua), Charlottenlund Slot, JægersborgAllé 1, 2920 Charlottenlund, Denmark		clu@aqua.dtu.dk
van Hoof, Luc	IMARES, Haringkade 1, Ijmuiden, The Netherlands	Tel.: +31 61061991	Luc.vanhoof@wur.nl
Vanhee, Willy	Independent consultant		wvanhee@telenet.be
van Oostenbrugge, Hans	Fisheries Economics, Wageningen Economic Research, formerly LEI Wageningen UR, The Hague, The Netherlands		Hans.vanOostenbrugge@wur.nl
Vrgoc, Nedo	Institute of Oceanography and Fisheries, Split, Setaliste Ivana Mestrovica 63, 21000 Split, Croatia	Tel.: +385 21408002	vrgoc@izor.hr

Expert Working Group EWG-16-17 report

Report to the STECF

EXPERT WORKING GROUP ON Mediterranean assessments part 2 (EWG-16-17)

Ispra, Italy, 19 - 25 Nov 2016

This report does not necessarily reflect the view of the STECF and the European Commission and in no way anticipates the Commission's future policy in this area.

1 Executive summary

The working group was held in Ispra, Italy, from 19 - 25 November 2016.

2 Findings and Conclusions of the Working Group

A total of 17 area/species combinations were evaluated. The EWG has carried out seven ages based analytical assessments with short term forecasts, F target and catch advice for 2017. All four deep-water rose shrimp assessments (GSAs 1, 9, 10 and 9, 10&11 combined) give very repeatable results from the XSA assessments with only minor retrospective revision. The Nephrops XSA assessments (GSA 9 and 11) are both considered to give reliable results, evaluation of residuals and retrospective performance support the view that the assessments are adequate for the provision of advice. The EWG noted issues with MEDITS data from 2011 in GSA 11 but also notes that this is not materially affecting the advice for Nephrops (though possibly resulting in a failure of the assessment for striped red mullet - see below) because the cohorts involved do not contribute to the terminal year of the assessment. The XSA assessment for striped red mullet in GSA 9 shows slightly poorer retrospective performance than the other six age based assessments. A considerable amount of the uncertainty in the older ages was dealt with by reducing the age of the plus group (to 4+).

The EWG provides advice for Nephrops in GSAs 17-18 combined, this is based on a long time series surplus production model. Having failed to resolve the diverse growth issues (see section 6.11). It is noted that the SPiCT model is sensitive to the choice of tuning series and that the longest time series which used the maximum years of catch information provides the narrowest confidence intervals in terminal F and SSB and is therefore the appropriate choice of assessment model.

The EWG considered that the XSA model for Nephrops in GSA 6 gave rise to concern, and that it pointed to either methodological or more likely data issues for the MEDITS survey in 2014/15. A three model approach is considered to clearly support the general conclusion that F in 2013 is above F0.1 by a factor of greater than 4 and that all the evidence points to F increasing further in 2014 and 2015.

It was not possible to carry out analytical age based assessments for anglerfish, european seabass, common sole and gilthead seabream (GSAs 1, 5, 6, 7). The EWG used of the VIT model. The EWG notes that although this model can give variable results from year to year due to the approach which assumes constant recruitment, in these cases the variability was small indicating the values of F and F0.1 appear to be relatively stable and suitable for advice. STECF also agrees with the EWG that this method is suitable for F estimates in these cases but not for biomass evaluations and not for evaluations of trend.

EWG was unable to provide advice for striped red mullet in GSA 11, european seabass in 1, 5, 6&7 and anglerfish in GSAs 6 and 7 individually. EWG would encourage the Commission to try to obtain more comprehensive data, particularly from Italy for GSA 11 and especially from France for GSA 7.

The EWG has refined the length indicator analysis giving much more stable evaluations of the length at first capture. For all the species GSA groupings in the ToR except for the Nephrops in GSAs 17&18 where a single growth model was not possible, length indicators were calculated. The length indicators show promise in terms of trend, and in all cases except common sole in GSA 7 give strong support to the other assessment. The disparity of F and length indicators for common sole in GSA 7 is why the EWG has not been able to evaluate magnitude of the F advice for this stock.

2.1 Stock-Specific Findings & Conclusions

See the stock specific summary sheets.

A range of analyses were considered for all stocks based on data available to the meeting (Table 2.1). For those suggested for level 1, 2 and 3 evaluations analytical age based assessments were attempted, and where these were found by the EWG to be of sufficient standard they have been used as the basis for advice; see Section 5 and the summary values in Table 2.2. Length analyses were carried out for all species/areas where sufficient length data was available. The results of these length analyses are included in the stock evaluations in Sections 6. The methods applied in EWG16-13 were refined by basing Lc (length at first capture on fitted 25 percentile on catch), which gave results that were much better coupled to the observed length distributions. Sensitive of resulting MSY index (LFeM) is still known to be sensitive to assumptions on L infinity (Linf) expert judgement was used and Linf values were carefully selected for each stock.

Table 2.1 Summary of work was attempted and basis for any advice. XSA, SepVPA and VIT are age based assessment methods; SPiCT is a surplus production model. STF is a standard short term projection with assumptions of status quo F and historic recruitment.

Area	Species	Suggested Analysis	Attempted analyses and basis of advice (in bold)
GSA 7	European seabass	Level 3 *	Length index, **VIT**
GSA 1-5-6-7	European seabass	Level 4	Insufficient data
GSA 6	Anglerfish	Level 2	Insufficient data
GSA 7	Anglerfish	Level 1	Insufficient data
GSA 1-5-6-7	Anglerfish	Level 1	Length index, **VIT**
GSAs 9	Striped red mullet	Level 1	Length index, **XSA, STF**
GSAs 11	Striped red mullet	Level 1	Length index, No advice
GSA 6	Norway lobster	Level 2	Length index, **SepVPA**,
GSA 9	Norway lobster	Level 1	Length index, **XSA**, **STF**
GSA 11	Norway lobster	Level 1 *	Length index, **XSA**, **STF**
GSA 17-18	Norway lobster	Level 1	**SPiCT Surplus Production, STF**
GSA 1	Deep-water rose shrimp	Level 1	Length index, **XSA**, **STF**
GSA 9	Deep-water rose shrimp	Level 1	Length index, **XSA**, **STF**
GSA 10	Deep-water rose shrimp	Level 1	Length index, **XSA**, **STF**
GSA 9-10-11	Deep-water rose shrimp	Level 1	Length index, **XSA**, **STF**
GSA 7	Common sole	Level 3 *	Length index, **VIT**
GSA 7	Gilthead seabream	Level 3 *	Length index, **VIT**

* stocks for which short term contacts were used prior to the EWG to assemble the data

Table 2.2 Summary of advice from EWG16-17 by area and species. F 2015 is terminal F in the assessment, used as Fstatus quo in the short term forecast. Change in F is the difference (as a fraction) between F in 2017 and the estimated F in 2015. Change in catch is from catch 2015 to catch 2017. Biomass status is given relative to BMSY where available, (Nephrops in 17&18) and as an indication of trend over the last 3 years for stocks with time series analytical assessments.

Species	Area	Method/ basis	F 2015	F 2017 for F0.1	Change in F	Catch 2015	Catch 2017 (see basis)	Change in catch	Biomass
European seabass	GSA 7	VIT	$3.4*F_{0.1}$	0.136	0.29	-	-	-	
European seabass	GSA 1-5-6-7	No advice	-	-	-	-	-	-	
Anglerfish	GSA 6	No advice	-	-	-	-	-	-	
Anglerfish	GSA 7	No advice	-	-	-	-	-	-	
Anglerfish	GSA 1-5-6-7	VIT	$3.1*F_{0.1}$	0.22	0.34	-	-	-	
Striped red mullet	GSA 9	XSA, STF	0.49	0.52	1.06	260	313	+20%	Declining
Striped red mullet	GSA 11	No advice	-	-	-	-	-	-	
Norway lobster	GSA 6	SepVPA,	$>4.0*F_{0.1}$	0.175	<0.25	-	-	-	Declining
Norway lobster	GSA 9	XSA,	0.34	0.19	0.56	114	83	-27%	stable
Norway lobster	GSA 11	XSA,	0.39	0.19	0.49	18.2	8.3	-54%	Stable
Norway lobster	GSA 17-18	SPiCT	$1.25*F_{MSY}$	0.38	0.77	1185	1288	+ 8%	$38\%B_{MSY}$
Deep-water rose shrimp	GSA 1	XSA, STF	0.78	0.87	1.1	114	138	21%	Declining
Deep-water rose shrimp	GSA 9	XSA, STF	0.71	0.71	1.0	881	798	-9%	Rising
Deep-water rose shrimp	GSA 10	XSA, STF	1.81	0.90	0.5	578	438	-24%	Declining
Deep-water rose shrimp	GSA 9-10-11	XSA, STF	0.87	0.91	1.0	1536	1585	3%	Stable
Common sole	GSA 7	VIT	Reduce F			-	-	-	
Gilthead seabream	GSA 7	VIT	2.0*F0.1	0.19	0.50	-	-	-	

2.2 Frequency of assessments

The frequency depends not only on the stock but also on the use of the information. For the short lived species (Deep-water rose shrimp) with full assessments these should be assessed annually if the advice is to be used to manage the fishery, less frequent advice is would be sufficient if monitoring stock status / exploitation rate is sufficient. For anglerfish (GSA 1, 5, 6 & 7), european seabass (GSA 7), common sole and gilthead seabream (GSA 7) the information is insufficient to carry out a full age based assessment and further evaluations could be carried out every three years to determine if new data improves knowledge on stock status or exploitation.

2.3 Evaluation of reference points

Stocks of Norway lobster and Deep-water rose shrimp evaluated below using age based assessment were all considered for further evaluation of MSY reference points. In the case of Norway lobster in GSAs 17-18 combined, the assessment is based on a surplus production model, which is intrinsically set in an MSY context. For this model it is not possible to carry out full stochastic evaluations and give MSY ranges that are precautionary, therefore Fupper is equal to Fmsy. For all the other full age bases assessments for Deep-water rose shrimp and Norway lobster the time series were considered for stochastic evaluations, but, the converged parts of these time series were all too short to characterise the dynamic of the stocks and allow stochastic evaluation of Fupper. Under these circumstances Fupper is set equal to FMSY. In no case has F lower been evaluated, as without an estimate of Fupper, Flower appears to be unnecessary, as any F below F0.1 is considered precautionary and would be compatible with the MSY approach.

3 Follow Up Items

3.1 Preparation of ToRs

Preparation for this WG was a considerable improvement on the previous meeting, the provision of an initial list of stocks in early October which was refined over a period of time and finalised in the first week in November, this process was an improvement over previous EWG, this allowed some evaluation of available data prior to the agreement of the stock list, then WG participants could be circulated with tasks and supplied with data more than 1 week prior to the EWG. Ad hoc contracts were used to help assembled some of the data in advance. So overall this is an undoubted improvement. However, the process of refining the stock list took over 2/3 of the available time from its original proposal before it was agreed, involving several options and each review cycle took at least 1 week. During this process Nephrops in 17-18 was proposed removed and reinserted. This approach is cumbersome inefficient and possibly could be improved both in terms of speed and outcome, and should reduce Commission workload as well as for JRC and EWG Chair. If the initial proposal identified roughly twice as many stocks as expected to be possible, then STECF secretariat could provide comments on data and potential issues for the longer list and then the Commission could hopefully select their preferences in one go. This cycle may not be possible within one week, but it would undoubtedly be quicker and thus more effective than the month or more used this time. It is also noted that EWG16-13 proposed that draft ToRs should be prepared prior to STECF Plenary in the spring. This process should start in January.

3.2 2017 Med meeting on methods

The EWG considered the work carried out through the autumn, and discussed deficiencies, and areas for development. The following tasks were identified to improve the situation based on the urgency of the improvements needed. They are ordered in priority based on the likelihood of improvements being possible:

1) Exploration of methods for converting length to ages, including methods for taking account uncertainty on length based analyses. Methods that are applied independently of assessment and methods also those that include assessments.
2) Methods to raise and combine survey data across GSAs.
3) Models for cephalopods - short lifespan, difficulties in aging?
4) Comparison of data poor and standard models.

Additional to the methods workshop the further improvement of assessment model expertise was also identified as a requirement for the group. This was identified as a possible role for JRC. In addition the possibility of inviting modelling experts to help set up suitable models and/or review model proposals.

The current way in which the Med EWGs are operating is more similar to the ICES benchmark process than the ICES WGs. Most of the assessments are evaluated over one or more models and model setting are fully evaluated before deciding on an assessment. This is a much greater revision / selection of model results than that associated just with an assessment WG. In ICES this process is augmented with reviewers who attend and fully participate in the Benchmarks. This is an efficient and effective process, much more efficient than external review which can result in either much more work after the meeting or a failure to resolve the reviewers comments (unless of course the reviews raise no issues). The inclusive approach makes full use of external reviews by ensuring they catch issues early and that areas of disagreement are explored quickly. STECF is strongly recommended to consider this approach for enhancing the Assessment EWGs.

4 Introduction

The expert working group on Mediterranean stock and fisheries assessment part 2 STECF-EWG16-17 was held Ispra (Italy), 19-25 November 2016.

4.1 Structure and basis of the report

The summary sheets by stock, provided in Section 5 contain catch advice. The basis of this advice depends on the type and quality of information available from the analyses and is as follows:

1) Full assessment and full MSY reference points or with surplus production model with F and biomass relative to F and Bmsy: Catch advice at MSY based on short term forecast.
2) Full assessment without full evaluation MSY reference points due to short time historic series Catch advice based on MSY proxy of F0.1 based on short term forecast.
3) Assessment providing SSB tend information historic F evaluation, not suitable for STF: Catch / Effort advice under precautionary considerations (Patterson 1992) F=FMSY with Harvest Rate (HR) based estimated SSB in most recent year**.- not used in this report**
4) For sparse data with insufficient years for VPA type analysis, advice is based on pseudo cohort analysis at equilibrium, with estimate of current F relative to F0.1
5) Trend based indicator with exploitation and stock status know to be OK: Catch / Effort advice under precautionary considerations based on ICES smoothed index of trend without precautionary buffer**.- not used in this report**
6) Trend based indictor: Catch / Effort advice under precautionary considerations based on ICES smoothed index of trend with precautionary buffer (20% reduction) **.- not used in this report**
7) Valid length analysis: statement of stock status, indication of direction of change required.
8) No valid analysis: no advice.

4.2 TERMS OF REFERENCE FOR EWG-16-17

Stock assessments in the Mediterranean Sea, Part II

19 -25 November 2016, Ispra, Italy

DG MARE focal persons: Xavier Vazquez & Amanda Perez

Chair: John Simmonds

GENERAL GUIDELINES: *unless the data used and information provided comes from the official DCF data calls, the experts are requested to indicate the data source from where certain information has been taken (e.g. L-W relationships, prices) or if it is an experts' reasoned deduction.*

Data collected outside the DCF shall be used as well and merged with DCF data following quality check whenever necessary. Due account shall also be taken of data used and assessments carried out within the Member States in particular when using data collected through the DCF/DCR and EU funded research projects, studies and other types of EU funding.

The raw data used to generate the input data, assessment scripts and all input files should be made available to the JRC before the end of the meeting to ensure reproducibility of the assessments and documentation.

TERMS OF REFERENCE:

For the stocks given in Annex I, the STECF-EWG 16-17 is requested to:

ToR 1. Data gathering

1.1. Compile and provide the most updated information on stock identification, age and growth, maturity, feeding, habitat, and natural mortality.

1.2. Compile and provide complete sets of annual data on landings and discards for the longest time series available up to and including 2015. This should be presented by fishing gear as well as by size/age structure (see Annex II for more details).

1.3. Compile and provide complete sets of annual data on fishing effort for the longest time series available up to and including 2015. This should be described in terms of amount of vessels, time (days at sea, soaking time, or other relevant parameter) and fishing power (gear size, boat size, horse power, etc.) by Member State and fishing gear. Data shall be the most detailed possible to support the establishment of a fishing effort or capacity baseline (see Annex II for more details).

1.4. Compile and provide indices of abundances and biomass by year and size/age structure for the longest time series available up to and including 2015 (see Annex II for more details).

ToR 2. Stock assessments (Level 1)

2.1. Assess trends in fishing mortality, stock biomass, spawning stock biomass, and recruitment. Different assessment models should be applied as appropriate. Models should be compared using model diagnostics including retrospective analyses when the models can produce one. The selection of the most reliable assessment should be justified. Assumptions and uncertainties should be reported.

2.2. Propose and evaluate candidate MSY value, range of values and safeguard points in terms of fishing mortality and stock biomass. The proposed values shall be related to long-term high yields and low risk of stock/fishery collapse and ensure that the exploitation levels restore and maintain marine biological resources at least at levels which can produce the maximum sustainable yield.

2.3. Provide short and medium[2] term forecasts of spawning stock biomass, stock biomass and catches. The forecasts shall include different management scenarios, *inter alia*: zero catch, the status quo fishing mortality, and target to F_{MSY} or other appropriate proxy by 2018 and 2020 (by means of a proportional reduction of fishing mortality as from 2017). In particular, predict the level of fishing effort exerted by the different fleets which is commensurate with the short- and medium-term forecasts of the proposed scenarios.

2.4. Make any appropriate comments and recommendations to improve the quality of the assessments. Furthermore, advise on the ideal assessment frequency.

ToR 3. Stock assessments (Levels 2-4)

3.1. Assess trends in fishing mortality, stock biomass, spawning stock biomass, and recruitment. Based on the precautionary approach, determine proxies MSY reference points on the exploitation level and the status of the stocks. Different assessment models should be applied as appropriate, including retrospective analyses when the models can produce one. The selection of the most reliable assessment should be explained. Assumptions and uncertainties should be specified.

3.2. Make any appropriate comments and recommendations to improve the quality of the assessment and/or to upgrade the assessment level and/or improve the quality of the data. Furthermore, advise on the ideal assessment frequency.

ToR 4. Summary sheets

Provide a synoptic overview of: (i) the fishery; (ii) the most recent state of the stock (spawning stock biomass, stock biomass, recruits, and exploitation level by fishing gear); (iii) the source of data and methods and; (iv) the management advice, including MSY value or proxies, range of values and safeguard points.

ToR 5. Data quality check

Summarize and concisely describe all data quality deficiencies, including possible limitations with the surveys of relevance for stock assessments and fisheries. Such review and description are to be based on the data format of the official DCF data call for the Mediterranean Sea launched on the 28 April 2016. Identify further research studies and data collections which would be required for improved fish stock assessments.

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[2] Medium term forecast only when an acceptable stock-recruitment relationship is identifiable.

ANNEX I
List of stocks given to assess

Target assessment level	Proposed stock boundaries	Common name	Scientific name
Level 3 *	GSA 7	European seabass	*Dicentrarchus labrax*
Level 4	GSA 1-5-6-7	European seabass	*Dicentrarchus labrax*
Level 2	GSA 6	Anglerfish	*Lophius piscatorius*
Level 1	GSA 7	Anglerfish	*Lophius piscatorius*
Level 1	GSA 1-5-6-7	Anglerfish	*Lophius piscatorius*
Level 1	GSAs 9	Striped red mullet	*Mullus surmuletus*
Level 1	GSAs 11	Striped red mullet	*Mullus surmuletus*
Level 2	GSA 6	Norway lobster	*Nephrops norvegicus*
Level 1	GSA 9	Norway lobster	*Nephrops norvegicus*
Level 1 *	GSA 11	Norway lobster	*Nephrops norvegicus*
Level 1	GSA 17-18	Norway lobster	*Nephrops norvegicus*
Level 1	GSA 1	Deep-water rose shrimp	*Parapenaeus longirostris*
Level 1	GSA 9	Deep-water rose shrimp	*Parapenaeus longirostris*
Level 1	GSA 10	Deep-water rose shrimp	*Parapenaeus longirostris*
Level 1	GSA 9-10-11	Deep-water rose shrimp	*Parapenaeus longirostris*
Level 3 *	GSA 7	Common sole	*Solea solea*
Level 3 *	GSA 7	Gilthead seabream	*Sparus aurata*

** Stocks subject to ad-hoc contracts.*

ANNEX II

Guidance for the preparation of the final report (specific sections 1.5 – 1.7)

SECTION 1.5	**FISHERIES**	**<u>Landings</u>** Total landings/year * Landings/fishing gear/year * Landings /fishing gear/year/size structure Landings /fishing gear/year/age structure **<u>Discards</u>** Total discards/year * Discards/fishing gear/year * Discards/fishing gear/year/size structure Discards/fishing gear/year/age structure **<u>Fishing effort</u>** Fishing effort (GT*days at sea)/year * Fishing effort (GT*days at sea)/fishing gear/year * Fishing effort (Days at sea)/year * Fishing effort (Days at sea)/fishing gear/year *
SECTION 1.6	**SCIENTIFIC SURVEYS**	Abundance index/year Abundance index/year/size structure Abundance index/year/age structure Biomass index/year Biomass index/year/size structure Biomass index/year/age structure
SECTION 1.7	**STOCK ASSESSMENT**	**<u>Results</u>** * Fishing mortality Fishing mortality/fishing gear Recruitment SSB TB **<u>Reference points</u>** * F_{MSY}, F_{upper} and F_{lower} B_{MSY}, B_{lim}, B_{pa} **<u>Predictions</u>** * *For the different scenarios,* Fishing mortality Fishing mortality/fishing gear Catches Catches/fishing gear Fishing effort/fishing gear SSB

** Please provide these variables at least in values (not only figures).*

4.3 LENGTH BASED INDICATORS

Length based indicators based on those reported in ICES WKLIFE V (2015) were calculated for the stocks and GSAs of interest. Only *Lmean* relative to *LFeM* (*Lmean/LfeM*) was used in the final analysis. It can be used as an indicator of FMSY and is recommended to be >= 1, i.e. a value < 1 suggests overfishing.

Lmean is the mean length of individuals larger than the smallest length in the catch; *Lc*. *LFeM* is calculated as 0.75 *Lc* + 0.25 *Linf*. Values for *Linf* were taken from the DCF database where available or expert opinion was used.

Lmean/LfeM is very dependent on the value of *Lc*. In the previous STECF Mediterranean meeting (STECF-EWG16-13) the calculation of *Lc* was based on the ICES R script, *LBindicators.R*, by T. Miethe and C. Silva (ICES, 2015) where *Lc* depends on the mode of the catch distribution at length. In the R script the mode was taken to be the count in the first length class for which the following length class has a decreased count, i.e. the first peak in the catch distribution starting from the smallest size. This was not necessarily the largest peak in the data, and could be the first peak of a multimodal distribution. The length class which contained half this mode was then taken as *Lc*.

It was found that this method for calculating *Lc* was very sensitive to the shape and sparsity of the catch distribution leading to *Lc* values that varied strongly between years, even when the catch distributions were similar. To help overcome some of the sensitivity it was recommended that the bin widths of the catch distribution were adjusted to ensure a smooth distribution for the calculation of *Lc*.

An alternative approach was proposed by Miethe (2016 pers. comm.) where the 0.25 quantile of the catch distribution was used as *Lc*. This method was also applied here. A normal cumulative probability distribution was fitted to the catch-at-length distribution of each year. The estimated mean and standard deviation of the distribution was then used to calculate *Lc* as the 0.25 quantile of the estimated distribution. It was found that this gave a much more stable value for *Lc* than the original method that used the first mode in the data and gave greater confidence in the calculation of the length indicator.

Two plots are produced for the stocks. The first one shows the catch distribution with *Linf* and the estimated values of *Lmean*, *Lc* and *LfeM* superimposed. The second shows the indicator *Lmean/LfeM* through time with a smoother line added. As mentioned above, *Lmean/LfeM* can be taken as an indicator of FMSY and is recommended to be >= 1. However, it is perhaps better to use the indicator for trends, i.e. is F increasing or decreasing over time.

All the R code for the analysis can be found in the Git repository: https://fishreg.jrc.ec.europa.eu/gitlab/scottfi/med_length_indicators.git

<u>References</u>

ICES. 2015. Report of the Fifth Workshop on the Development of Quantitative Assessment Methodologies based on Life-history Traits, Exploitation Characteristics and other Relevant Parameters for Data-limited Stocks (WKLIFE V), 5–9 October 2015, Lisbon, Portugal. ICES CM 2015/ACOM:56. 157 pp.

5 Summary sheets by stock

Provide a synoptic overview of: (i) the fishery; (ii) the most recent state of the stock (spawning stock biomass, stock biomass, recruits, and exploitation level by fishing gear); (iii) the source of data and methods and; (iv) the management advice, including MSY value or proxies, range of values and safeguard points.

5.1 SUMMARY SHEET OF EUROPEAN SEABASS IN GSA 7

Species common name: European seabass

Species scientific name: *Dicentrarchus labrax*

Geographical Sub-area(s) GSA(s): 7

5.1.1 Stock development over time

State of the adult abundance and biomass

The data does not allow for evaluation of abundance over time, evaluations of recent years estimate recent biomass over last three years is 379 tonnes.

State of the juveniles (recruits)

The data does not allow for evaluation of recruitment over time, so current recruitment cannot be compared with historic recruitment.

State of exploitation

F in recent years is estimated a high and variable at 3.4 time F0.1 (F MSY proxy), Estimates of F0.1 are found to be stable at 0.136. The length indicator evaluations supports the conclusion of F>FMSY but does not provide a factor describing the extent of over exploitation.

5.1.2 Stock advice

STECF EWG 16-17 advises that when MSY considerations are applied the fishing mortality in 2017 should be reduced to no more than 29% of current F.

5.1.3 Basis of the assessment

The assessment is based on three years of data evaluated independently with VIT.

5.1.4 Catch options

A short term forecast cannot be carried out, and no specific catch options can be provided

5.1.5 Reference points

Table 5.1.5.1. European seabass in GSA 7. Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$		Not defined	
	F_{MSY}	0.136	VIT assessment and YPR evaluation of FMSY Proxy (F0.1)	This Report

5.1.6 Data Deficiencies

Data for this species is currently very limited. Catch per unit of effort estimates are not feasible as effort information is incomplete. The lack of detailed fleet based effort data from the dominant fleets (French) is critical current level of aggregation in reporting do not allow to separate the fraction of vessels that fish this stock to be identified. Without such information is not possible to derive cpue values that may help to find any change in abundance along time. Specific effort information for the other gears is completely lacking. Almost complete landings data by métier is only available in last three years for French catches (that represent more than 95% of the total). Size/age structure of the commercial catch for all the métiers that capture the species is only available for the same three year period.

5.2 SUMMARY SHEET OF EUROPEAN SEABASS IN GSA 1, 5, 6 AND 7

Species common name: European seabass

Species scientific name: *Dicentrarchus labrax*

Geographical Sub-area(s) GSA(s): 1,5,6,7

Catches reported from GSAs 1, 5 and 6 are negligible in comparison to GSA 7, and do not come with any biological information. The status of the stock and fishery in the combined area cannot be evaluated, but is considered best represented by analysis for GAS 7.

5.3 SUMMARY SHEET OF ANGLERFISH IN GSA 6

Species common name: Monk fish

Species scientific name: *Lophius piscatorious*

Geographical Sub-area(s) GSA(s): 6

No Separate evaluation possible, please see Section 5.5 anglerfish in GSAs 1, 5, 6 AND 7

5.4 SUMMARY SHEET OF ANGLERFISH IN GSA 7

Species common name: Monk fish

Species scientific name: *Lophius piscatorius*

Geographical Sub-area(s) GSA(s): 7

No Separate evaluation possible, please see Section 5.5 anglerfish in GSAs 1, 5, 6 AND 7.

5.5 SUMMARY SHEET OF ANGLERFISH IN GSAs 1, 5, 6 AND 7

Species common name: Monk fish

Species scientific name: *Lophius piscatorious*

Geographical Sub-area(s) GSA(s): 1,5,6,7

5.5.1 Stock development over time

This is the first assessment of *L. piscatorius* in GSA 1, 5, 6 and 7, The data does not allow for evaluation of abundance over time.

State of the adult abundance and biomass

The data does not allow for evaluation of abundance over time, evaluations of recent years estimate recent biomass over last three years as 302 tonnes

State of the juveniles (recruits)

The data does not allow for evaluation of recruitment over time, so current recruitment cannot be compared with historic recruitment.

State of exploitation

F in recent years is estimated as 3.1 time F0.1 (F_{MSY} proxy). Three year average estimates of mean F0.1 = 0.22 (0.18 to 0.27). The length indicator evaluations supports the conclusion of F>FMSY but does not provide a factor describing the extent of over exploitation.

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5.5.2 Stock advice

STECF EWG 16-17 advises that when MSY considerations are applied the fishing mortality in 2017 should be to reduce F to no more than 34% of F in 2013-15.

5.5.3 Basis of the assessment

The data used in the assessment were: (i) Landings time series 2013-2015 from OTB; (ii) Age distributions obtained from slicing of length distributions 2013-2015 (Figure 5.2.2.6.3.1) using the von Bertalanffy growth parameters from Landa et al. (2008); (iii) Natural mortality vector (calculated using PRODBIOM; Abella et al. 1997); (iv) Maturity ogive (determined from the aged-based maturity ogive by sex provided by Duarte et al. (2001) and using the sex-ratio calculated from the MEDITS surveys) and; (v) the length-weight relationship parameters from García-Rodríguez (2000). The assessment was based on a pseudocohort analysis using the VPA equations, and was carried out using the VIT software (Lleonart and Salat, 1992). A Yield per Recruit analyses (Y/R) (Beverton and Hold, 1957) was carried out to calculate the biological reference points FMSY and F0.1 using the output results of the VIT.

5.5.4 Catch options

A short term forecast cannot be carried out, and no specific catch options can be provided

The species is of secondary commercial importance (by catch), but regularly caught by bottom trawlers and to, a lesser extent, set nets (2-3% of the total landings in 2013). Most of the landings correspond to individuals between 20 and 50 cm TL, which are often sold together with L. budegassa which contributed about 70% of the catches in average during the last years.

The recent change of 40 mm diamond to 40 mm square mesh in the codend has not shown any improvement in the selectivity for L. piscatorius, which is completely retained in the cod end. Sizes of mesh to achieve selectivity for this species would probably be economically unsustainable for the fleet. Taking this into account the only way to reduce F would be an effort reduction.

5.5.5 Reference points

The VIT and YPR analysis provide estimates of recent F0.1 see Table below

No biomass reference points have been proposed for this stock. As a result EWG 16-17 is unable to fully assess the status of the stock with respect to biomass. It must be taken into account that there are no data on deeper bottoms than 800 m where according to our results it seems that a fraction of the population that includes the biggest spawner habitat.

Table 5.5.5.1. Monk fish in GSAs 1,5,6,7. Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$		Not Defined	
	F_{MSY}	0.22	VIT assessment and YPR evaluation of FMSY Proxy (F0.1)	This Report

5.5.6 Data Deficiencies

There are inconsistencies in the declared landings from GSA7 between the Spanish and French bottom trawl fleets. More consistent reporting by gear from all GSAs and countries, with larger numbers of samples, are needed in order to establish accurate catch at length.

5.6 SUMMARY SHEET OF STRIPED RED MULLET IN GSA 9

Species common name: Striped red mullet

Species scientific name: *Mullus surmuletus*

Geographical Sub-area(s) GSA(s): 9

5.6.1 Stock development over time

State of the adult abundance and biomass

SSB has shown very mild negative trend as the maximum value was observed in 2006 (594.83 t) and 463.48 t was estimated in 2015.

State of the juveniles (recruits)

Recruits have shown stable trend during the period from 2006 to 2015 with maximum in 2006 with 22568 and current at 16625 tonnes.

State of exploitation

F bar (0-3) has been showing declining trend in recent years with maximum of 0.91 in 2011 and current value of 0.49 which is below the FMSY proxy (F0.1 =0.52).

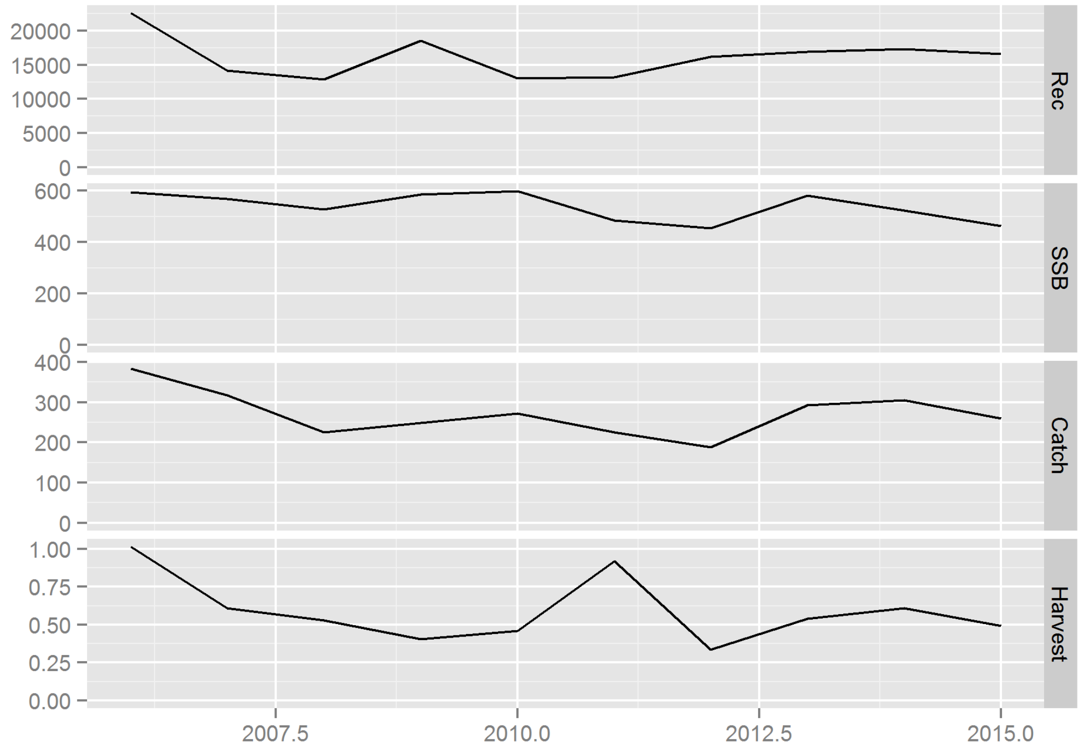


Figure 5.6.1 Recruitment, SSB (t); catch (t) and fishing mortality from 2006 to 2015.

Table 5.6.1. Striped red mullet in GSA 9. XSA results. Recruitment. SSB. Catch. F.

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Recruits	22568	14225	12871	18556	13271	13352	16264	17069	17318	16625
Fbar	1.015	0.611	0.530	0.406	0.461	0.919	0.336	0.541	0.610	0.492
SSB	594.83	568.51	526.32	585.13	598.77	483.86	453.29	580.34	522.63	463.48
Catch	383.10	316.96	225.04	248.61	272.30	224.49	187.73	292.19	304.78	259.94

5.6.2 Stock advice

STECF EWG 16-17 advises that when MSY considerations are applied the fishing mortality in 2017 should no more than F=0.52 this implies catches of no more than 313 tons.

5.6.3 Basis of the assessment

Assessment is based on the DCF data and tuned with MEDITS data. Assessment was done in XSA in FLR environment. Reference points are estimated with FLRBRP

5.6.4 Catch options

Table 6.6.4.9. Striped red mullet in GSA 9. Short term prediction with three year average population and fishery selection, assuming status quo F2016 = 0.483 (catch 2016 = 281 t)

Rationale	F factor	Fbar	Catch 2017	Catch 2018	SSB 2017	SSB 2018	Change SSB 2017-2018(%)	Change Catch 2015-2017(%)
ZERO CATCH	0.000	0.000	0.000	0.000	556.513	853.652	53.393	-100.000
F 0.1	1.072	0.52	312.724	312.894	556.513	567.885	2.043	20.307
STATUS QUO	1.000	0.483	296.730	302.052	556.513	581.366	4.466	14.154
Different scenarios	0.100	0.048	37.574	49.769	556.513	817.139	46.832	-85.545
	0.300	0.145	106.533	132.005	556.513	751.519	35.041	-59.016
	0.500	0.242	168.206	195.925	556.513	694.491	24.793	-35.290
	0.700	0.338	223.596	245.968	556.513	644.735	15.853	-13.981
	0.900	0.435	273.556	285.459	556.513	601.145	8.020	5.239
	1.100	0.531	318.809	316.891	556.513	562.792	1.128	22.648
	1.300	0.628	359.975	342.140	556.513	528.895	-4.963	38.485
	1.500	0.725	397.577	362.623	556.513	498.798	-10.371	52.951
	1.700	0.821	432.067	379.409	556.513	471.949	-15.195	66.219
	1.900	0.918	463.827	393.310	556.513	447.881	-19.520	78.438

5.6.5 Reference points

Table 5.6.5.1. Striped red mullet in GSA 9. Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$		Not defined	
	F_{MSY}	0.52	XSA assessment and YPR evaluation of FMSY Proxy (F0.1)	This Report

5.6.6 Data Deficiencies

No specific data deficiencies have been identified.

5.7 SUMMARY SHEET OF STRIPED RED MULLET IN GSA 11

Species common name: Striped red mullet

Species scientific name: *Mullus surmuletus*

Geographical Sub-area(s) GSA(s): 11

5.7.1 Stock development over time

EWG 16-17 was unable to evaluate the status of the stock due to inconsistent data.

State of the adult abundance and biomass

State of the juveniles (recruits)

State of exploitation

5.7.2 Stock advice

EWG 16-17 was unable provide stock advice due to inconsistent data.

5.7.3 Basis of the assessment

EWG 16-17 was unable to evaluate the status of the stock due to inconsistent data.

5.7.4 Catch options

EWG 16-17 was unable to provide catch options due to inconsistent data.

5.7.5 Reference points

EWG 16-17 was unable to evaluate reference pointsdue to inconsistent data..

5.7.6 Data Deficiencies

All observations concerning the data are described in detail in section 6.7.1.

Catch data supplied showed inconsistencies throughout, both in terms of allocations to gear and SOP deviations. The data sets need to be checked.

5.8 SUMMARY SHEET OF NORWAY LOBSTER IN GSA 6

Species common name: Norway lobster

Species scientific name: *Nephrops norvegicus*

Geographical Sub-area(s) GSA(s): 6

5.8.1 Stock development over time

No specific assessment run was selected due to the lack of a reliable tuning index illustrated by the discrepancies observed between the trends of landings and MEDITS indices. However, some insights have been gained on the biomass and exploitation state of this stock by the different assessments that were carried out.

State of the adult abundance and biomass

SSB has been decreasing after 2010 as indicated by both the XSA and separable VPA runs that were tried (Figure 5.8.1.1). SSB in 2015 was found to be 1.7-3.4 times lower than that in 2010.

State of the juveniles (recruits)

Recruitment has been decreasing after 2011 as indicated by both the XSA and separable VPA runs that were carried out (Figure 5.8.1.1). An increase in recruitment in 2015 has been indicated by the XSAs (Figure 5.8.1.1a) but not by the separable VPAs (Figure 5.8.1.1b).

State of exploitation

Both the XSA and separable VPA runs showed that F(2-6) in 2013 (F(2-6)=0.8) was at least four times higher than F0.1, and that F has further increased in 2014 and 2015 (Figure 5.8.1.1). The length indicator analysis also shows that F is greater than FMSY and shows an increasing trend in F with time. Therefore, the stock is considered to be harvested above Fmsy.

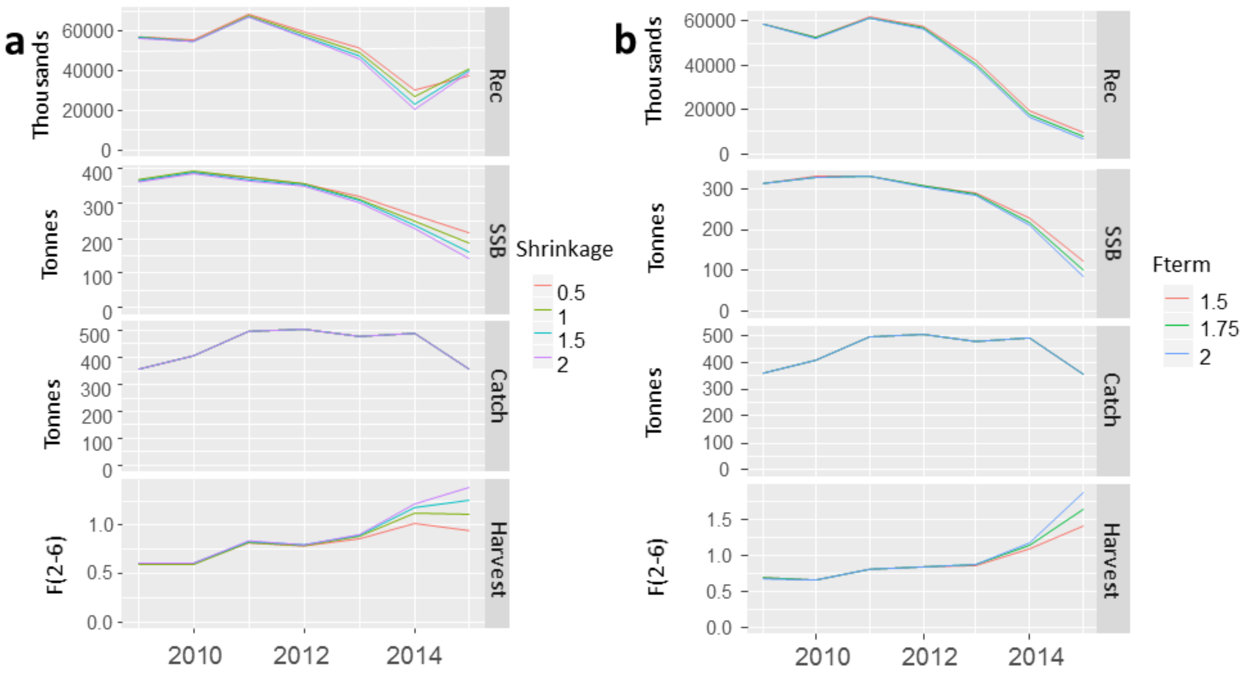


Figure 5.8.1.1 Norway lobster in GSA 6. Stock summaries produced by XSAs with different shrinkages (a) and from separable VPAs with different Fterm values (b).

5.8.2 Stock advice

STECF EWG 16-17 advises that when MSY considerations are applied the fishing mortality in 2017 should be reduced to no more than 25% of current F.

5.8.3 Basis of the assessment

Two types of age based assessment were carried out for this stock: an XSA and a separable VPA. The analysed data consisted of landings LFDs and weights at age coming from the DCF for the period 2009-2015, and biological parameters taken from the DCF corresponding to *N. norvegicus* in GSA 9. For the XSA, MEDITS data for the period 2009-2015 were used to produce a tuning index. The assessment is considered to provide estimates of the state of the stock in 2013 with direction of change (increasing F and decreasing SSB) since then. Length indicator based evaluations are used to support the conclusions.

5.8.4 Catch options

No short-term forecasts with different catch options were carried out for this stock, due to lack of stock estimate for 2015

5.8.5 Reference points

Stocks produced by XSA runs with different Shrinkages resulted in F0.1(2-6) values ranging from 0.170 to 0.174. The stocks produced by the optimal separable VPAs had a F0.1(2-6) value of 0.178.

Table 5.8.5.1. Norway lobster in GSA 6. Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$			
	F_{MSY}	0.175	XSA assessment and YPR evaluation of FMSY Proxy (F0.1)	This Report

5.8.6 Data Deficiencies

The main data deficiency observed was the mismatch between the trends of landings and MEDITS, which hindered the production of a reliable XSA assessment. The reliability of the MEDITS data for 2014 and 2015 needs to be investigated.
Some entries in the MEDITS LFD data were in millimetres instead of centimetres and were corrected prior to the assessments.
MEDITS LFDs of year 2001 had a different range in the length classes compared to the other years (5 mm instead of 1 mm), but this did not affect the assessments.
No data on growth, maturity and sex ratio were available in the DCF for this stock.

5.9 SUMMARY SHEET OF NORWAY LOBSTER IN GSA 9

Species common name: Norway lobster

Species scientific name: *Nephrops norvegicus*

Geographical Sub-area(s) GSA(s): 9

5.9.1 Stock development over time

State of the adult abundance and biomass

According to the XSA results, SSB estimates showed a decreasing pattern until 2014, recovering slightly in 2015. No precautionary biomass reference points have been proposed for Norway lobster. Therefore, the status of the spawning stock biomass with respect to the precautionary limits is not known.

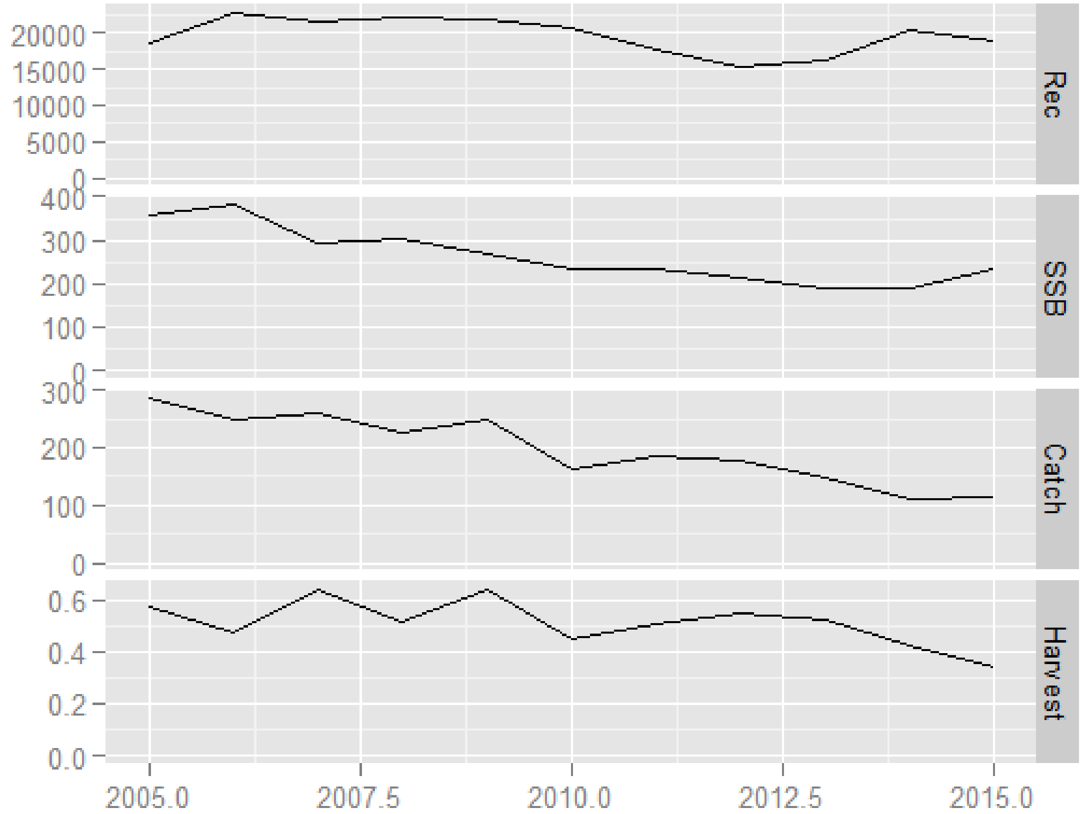


Figure 5.9.1.1. Norway lobster in GSA 9. Assessment results recruitment, SSB(t), landings(t) and Fishing mortality.

Table 5.9.1.1. Norway lobster in GSA 9. Norway lobster in GSA 9. Assessment results recruitment, SSB(t), landings(t) and Fishing mortality.

Year	Catch (t)	R (Age 1)	SSB (t)	Fbar(2-6)
2005	287.6	18753	357.73	0.574
2006	247.39	22953	382.16	0.476
2007	260.55	21513	294.22	0.638
2008	227.67	22073	301.43	0.514
2009	250.24	21995	266	0.637
2010	161.61	20864	231.37	0.444
2011	183.92	17885	233.2	0.506
2012	177.84	15255	215.81	0.543
2013	147.65	16180	190.08	0.521
2014	111.52	20493	189.01	0.420
2015	113.62	18986	234.52	0.339

State of the juveniles (recruits)

Recruitment (age 1 individuals) has fluctuated over period 2005 – 2015, with the lowest value of 15.255 million individuals in 2012, the two last years (2014 and 2015) are close to the mean of the series.

State of exploitation

There is decreasing trend in both F and landings, F is estimated to be 0.34 and is above the estimated reference value of FMSY proxy (F0.1=0.194). The stock is therefore considered to be being been harvested above Fmsy.

5.9.2 Stock advice

STECF EWG 16-17 advises that when MSY considerations are applied the fishing mortality in 2017 should no more than F=0.19 this implies catches of no more than 83 tons.

5.9.3 Basis of the assessment

An XSA analysis was performed using 2005-2015 DCF data (biomass landed and age composition of the catches), tuned with fishery independent abundance indices (MEDITS survey). A vector of natural mortality was obtained applying PRODBIOM. In addition, Yield per Recruit (YPR) analysis was performed for the estimation of F0.1 (i.e. proxy of FMSY).

5.9.4 Catch options

Short-term prediction results are shown in the following Table (Table 5.9.4.1).

Table 5.9.4.1 Norway lobster in GSA 9. Short term prediction with three year average natural mortality, growth and fishery selection, assuming status quo F2016 = 0.46 (catch 2016 = 171.65 t)

	Ffactor	Fbar	Catch 2017	Catch 2018	SSB 2017	SSB 2018	Change_SSB 2017-2018(%)	Change_Catch 2015-2018(%)
Zero catch	0.00	0.00	0.00	0.00	316.41	479.76	51.63	-100.00
High long term yield (F0.1)	0.42	0.19	82.98	100.91	285.27	359.15	25.90	-26.97
Status quo	1.00	0.46	171.51	167.44	248.15	247.33	-0.33	50.95
Different scenarios	0.10	0.05	21.27	29.51	308.71	447.47	44.95	-81.28
	0.30	0.14	60.70	77.56	293.94	390.09	32.71	-46.57
	0.50	0.23	96.37	113.64	279.95	341.08	21.84	-15.19
	0.70	0.32	128.66	140.40	266.71	299.18	12.18	13.23
	0.90	0.41	157.92	159.89	254.16	263.30	3.59	38.99
	1.10	0.50	184.47	173.75	242.29	232.54	-4.02	62.36
	1.30	0.60	208.59	183.27	231.04	206.12	-10.79	83.58
	1.50	0.69	230.52	189.45	220.39	183.39	-16.78	102.89
	1.70	0.78	250.49	193.09	210.29	163.82	-22.10	120.47

1.90	0.87	268.70	194.82	200.72	146.92	-26.80	136.49

5.9.5 Reference points

Table 5.9.5.1. Norway lobster in GSA 9. Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$		Not defined	
	F_{MSY}	0.194	XSA assessment and YPR evaluation of FMSY Proxy (F0.1)	This Report

5.9.6 Data Deficiencies

Data from EU DCF as submitted through the official data call in 2016 were used. Numbers of individuals at length by metier were missing to OTB DEMSP (2005) and OTB DWSP for several years between 2008 and 2015. In these cases raising factors were applied.

5.10 SUMMARY SHEET OF NORWAY LOBSTER IN GSA 11

Species common name: Norway lobster

Species scientific name: Nephrops norvegicus

Geographical Sub-area(s) GSA(s): 11

5.10.1 Stock development over time

State of the adult abundance and biomass

According to the XSA assessment after a small increase to a peak in 2008 (88 t), the stock decreases reaching the lowest value of the time series in the last two years (39 t).

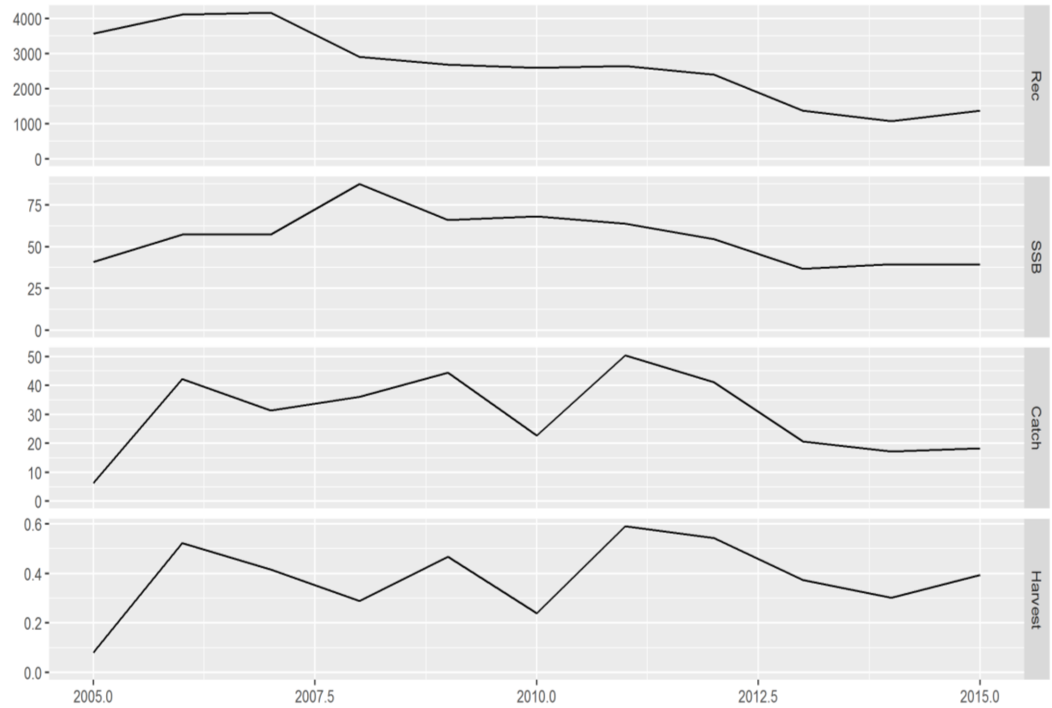


Figure 5.10.1.1. Norway lobster in GSA 11. Assessment results, recruitment, SSB (t) catches (t) and Fishing mortality.

Table 5.10.1.1. Norway lobster in GSA 11. Assessment results, recruitment, SSB (t) catches (t) and Fishing mortality.

year	ssb	rec	landings	fbar
2005	40.8	3567	6.3	0.08
2006	57.1	4110	42.3	0.52
2007	57.3	4169	31.3	0.41
2008	87.7	2910	36.2	0.29
2009	66.1	2681	44.4	0.47
2010	68.2	2591	22.8	0.24
2011	63.9	2641	50.5	0.59
2012	54.4	2403	41.1	0.54
2013	36.7	1373	20.6	0.37
2014	39.5	1075	17.2	0.3
2015	39.1	1372	18.2	0.39

State of the juveniles (recruits)

Recruitment (age 1 individuals) has been steadily decreasing over period 2006 – 2015, with the lowest value of 1.075 million individuals in 2014, and a weak increase in 2015.

State of exploitation

There is a decreasing trend in both F and landings, F is estimated to be 0.39 which is above the estimated reference value of $F_{0.1}$=0.19. The stock is considered to be being harvested above FMSY.

5.10.2 Stock advice

STECF EWG 16-17 advises that when MSY considerations are applied the fishing mortality in 2017 should no more than F=0.19 this implies catches of no more than 8.3 tons.

5.10.3 Basis of the assessment

An XSA analysis was performed using 2005-2015 DCF data (biomass landed with no discards and age composition of the catches by sex combined), tuned with fishery independent abundance indices (MEDITS survey). A vector of natural mortality was obtained by PRODBIOM. In addition, Yield per Recruit (YPR) analysis was performed for the estimation of $F_{0.1}$ (i.e. proxy of F_{MSY}).

5.10.4 Catch options

Short-term prediction results are shown in the following Table (Table 5.10.4.1).

Table 5.10.4.1 Norway lobster in GSA 11. Short term forecast in different F scenarios. Basis: F(2016) = mean($F_{bar\ (2-6)}$ 2013-2015)= 0.35; R(2016) = geometric mean of the recruitment of the last three years = 1265.37 (thousands); SSB(2015) = 39.1 t, Catch (2016) = 15 t

Rationale	Ffactor	Fbar	Catch_2017	Catch_2018	SSB_2018	Change_SSB 2017-2018(%)	Change_Catch 2015-2017(%)
Zero catch	0.0	0.00	0.0	0.0	49.1	28	-100
High long term yield (F0.1)	0.5	0.19	8.3	9.0	37.4	7	-54
Status quo	1.0	0.35	14.10	13.37	14.10	-8	-23
Different Scenarios	0.2	0.07	3.2	3.9	44.4	19	-82
	0.3	0.11	4.7	5.6	42.3	15	-74
	0.4	0.14	6.2	7.1	40.3	12	-66
	0.5	0.18	7.6	8.4	38.3	8	-58
	0.6	0.21	9.0	9.6	36.5	5	-51
	0.7	0.25	10.4	10.7	34.8	1	-43
	0.8	0.28	11.6	11.7	33.1	-2	-36
	0.9	0.32	12.9	12.6	31.6	-5	-29
	1.0	0.35	14.1	13.4	30.1	-8	-23
	1.1	0.39	15.3	14.1	28.7	-11	-16
	1.2	0.42	16.4	14.7	27.3	-13	-10
	1.3	0.46	17.5	15.2	26.1	-16	-4
	1.4	0.50	18.6	15.7	24.9	-19	2
	1.5	0.53	19.6	16.1	23.7	-21	7
	1.6	0.57	20.6	16.4	22.6	-23	13
	1.7	0.60	21.5	16.7	21.6	-26	18
	1.8	0.64	22.5	17.0	20.6	-28	23
	1.9	0.67	23.4	17.2	19.7	-30	28
	2.0	0.71	24.2	17.3	18.8	-32	33

5.10.5 Reference points

Table 5.10.5.1. Norway lobster in GSA 11. Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$		Not defined	
	F_{MSY}	0.19	XSA assessment and YPR evaluation of FMSY Proxy (F0.1)	This Report

5.10.6 Data Deficiencies

Data on growth parameters of *N. norvegicus* in GSA 11 were only available for males and pertain to a long unique period (2005-2015). While it is well know that male and female exhibit different growth patterns, the provision of growth parameters by sex and shorter time periods, the sex ratios by length and year in the catches, would allow to carry out more accurate assessments in the future, whereby data could be split by sex.

5.11 SUMMARY SHEET OF NORWAY LOBSTER IN GSAs 17 AND 18

Species common name: Norway lobster

Species scientific name: *Nephrops norvegicus*

Geographical Sub-area(s) GSA(s): 17 and 18

5.11.1 Stock development over time

State of the adult abundance and biomass

The stock assessment shows that the relative biomass (B/B_{MSYd}) is continuously decreasing since the 1960s, dropping below B_{msyd} (6355 t) in the last ten years (B=2450 t in 2015; B_{2015}/B_{MSYd} = 0.383; Figure 5.11.1.1, time series are summarized in Table 5.11.1.1.). The stock biomass is considered to be depleted ($B<<B_{MSYd}$).

State of the juveniles (recruits)

The recruitment has not been evaluated

State of exploitation

The fishing mortality has increasing since mid '80s with $F_{estimated}$ to be above F_{MSYd} in the last ten years (F_{2015}/F_{MSYd}= 1.253). The stock is considered to be over exploited $F>F_{MSYd}$, time series are summarized in Table 5.11.1.1.

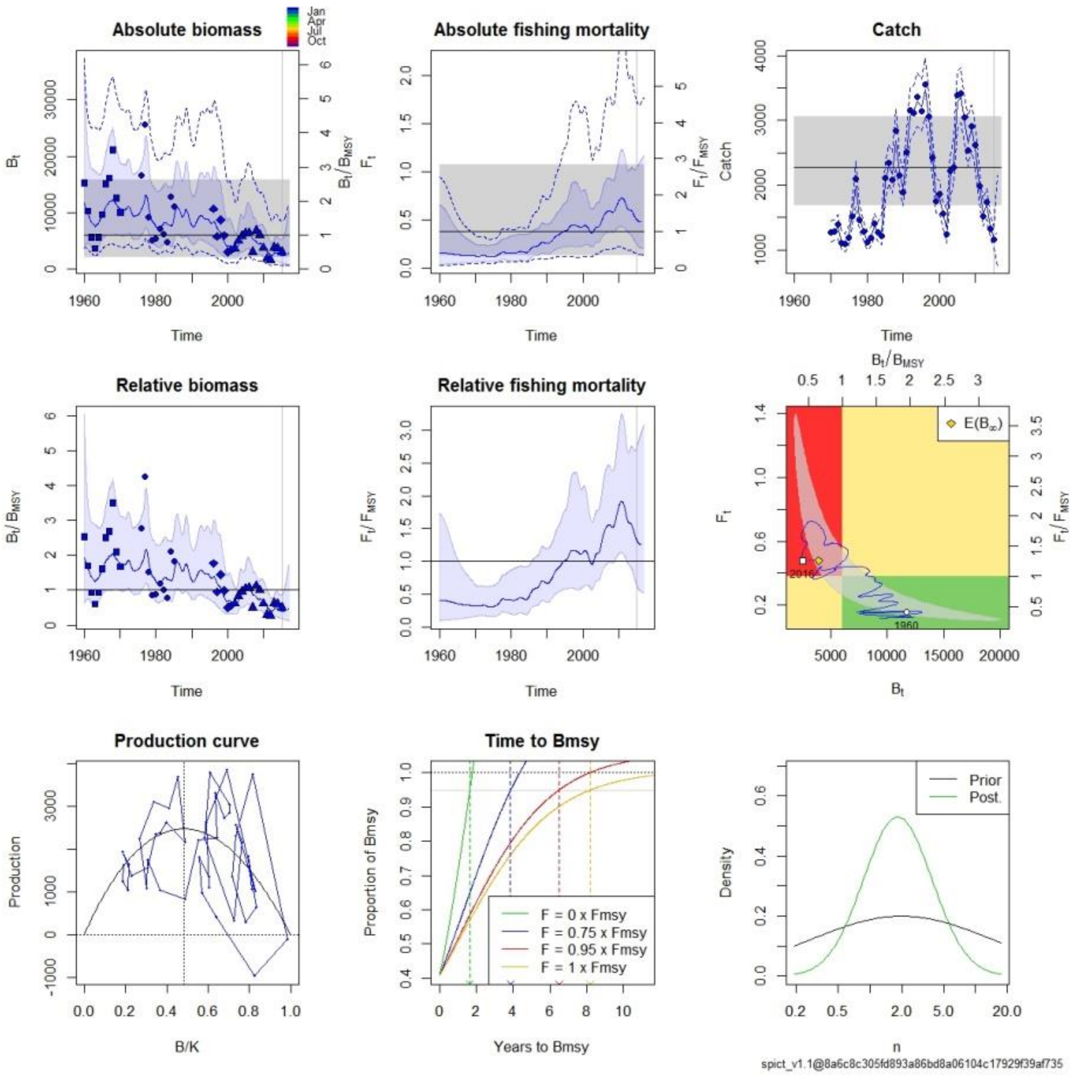


Figure 5.11.1.1. Norway lobster in GSAs 17-18. Final SPiCT model (Run#1) Absolute and relative Biomass and Fishing mortality, state of the stock in F/SSB space and relative to estimated production. Short term predictions (B rel Bmsyd) based on average productivity are provided for 0, .75, 0.95 Fmsyd and Fmsyd.

Table 5.11.1.1 Estimates of F/Fmsy, B/Bmsy and Catch time series from SPICT model Run#1 for Norway lobster in GSA 17-18. Fmsyd and Bmsyd are deterministic (Fmsyd = 0.388, Bmsyd = 6355 t) and Fs are the mean value of the year .

year	F/Fmsyd	B/Bmsyd	Catch
1970	0.311713056	1.654495	1274.415
1971	0.314123548	1.667447	1294.452
1972	0.319918437	1.717742	1358.189
1973	0.301924323	1.522564	1136.415
1974	0.29891909	1.494714	1104.11
1975	0.310332149	1.580854	1212.984
1976	0.347326	1.804989	1552.99
1977	0.408618824	1.970024	1987.44
1978	0.407832578	1.487609	1499.961
1979	0.406188032	1.270326	1275.206

1980	0.396683675	1.157419	1134.581
1981	0.406703588	1.193285	1199.698
1982	0.43006938	1.289285	1370.283
1983	0.417317199	1.236462	1275.19
1984	0.417512712	1.251708	1293.276
1985	0.505590201	1.621257	2032.05
1986	0.565951026	1.648026	2303.805
1987	0.590411593	1.487974	2171.608
1988	0.671019664	1.619241	2684.934
1989	0.662346815	1.336168	2188.795
1990	0.659597156	1.196154	1950.051
1991	0.740552516	1.358716	2490.892
1992	0.840245869	1.483499	3080.331
1993	0.898343855	1.416138	3143.053
1994	0.964743292	1.384362	3299.444
1995	1.00546143	1.293531	3214.073
1996	1.108100194	1.267239	3466.748
1997	1.139000534	1.080928	3042.509
1998	1.11493649	0.8829	2434.624
1999	1.085170289	0.677815	1817.369
2000	1.125766254	0.650575	1809.953
2001	1.050932327	0.594097	1544.934
2002	0.943562547	0.577153	1346.167
2003	1.052304837	0.809042	2108.585
2004	1.117371073	0.860521	2377.906
2005	1.316785531	1.007426	3281.911
2006	1.474859189	0.924813	3366.857
2007	1.51199332	0.800209	2990.023
2008	1.50071244	0.712581	2642.16
2009	1.682493611	0.688989	2860.904
2010	1.843732423	0.565326	2573.312
2011	1.791637494	0.437898	1941.995
2012	1.585653786	0.399707	1564.789
2013	1.51774111	0.451886	1694.953
2014	1.364471255	0.40264	1359.409
2015	1.252725385	0.38311	1185.877

5.11.2 Stock advice

STECF EWG 16-17 advises that when MSY considerations are applied the fishing mortality in 2017 should be reduced most to 79% of fishing mortality in 2015 this implies catches of no more than 1288.425 tons.

According to the short term forecast, keeping the current F will bring B to 60% of B_{MSYd} in 2020 (with a 50% probability). Fishing at F_{MSYd} will give B = 78%B_{MSYd} by 2020 and will bring the stock at

B_{msyd} after 8 years with a 50% probability. Therefore If managers require to achieve $B=B_{MSYd}$ by 2020 F should be less than F_{MSYd}.

5.11.3 Basis of the assessment

The assessment is based on SPiCT model (Stock Surplus Production model in Continuous Time) using the following data sources: landings in GSA 17-18: 1) Italian landings time series from National Institute for Statistics (ISTAT) for the period 1961-2000 for GSA 17 and 18; 2) GFCM landings for the period 1970-2014 for Croatia, Montenegro and Albania extracted from FAO database; 3) DCF landings from the 2015 DG MARE Data Call, covering the period 2002-2015 for GSA 17 and 18 (ITA) and GSA 17 (HRV).

Four tuning indices were used in the model: 1) CPUE (kg/Fishing day) from Jukic (1975) in the East part of Pomo Pit (Blitvenica fishing grounds); 2) Central Adriatic CPUE's from Froglia & Gramitto (1988) in the fishing grounds offshore Ancona (Western Central Adriatic); 3) MEDITS in GSA 17-18 1995-2001; 4) MEDITS in GSA 17-18 2002-2015, details on the CPUEs are in Section 6.11.

5.11.4 Catch options

Short-term prediction results are shown in the following Table (Table 5.11.4.1). For the short term SpiCT uses the F_{msy} and B_{msy} deterministic.

Table 5.11.4.1 Norway lobster in GSAs 17-18. Short term forecasts of status quo for different fishing mortalities reductions

Forecast Scenario	Year	Fishing mortality (F)	Biomass (B)	Catch
Keep current catch	2015	0.574294	2056.933	1181.317
	2016	0.582	1997.183	1162.351
	2017	0.587687	1980.898	1164.145
	2018	0.587566	1980.012	1163.385
	2019	0.582022	1996.654	1162.080
	2020	0.572077	2042.376	1168.342
Keep current F	2015	0.487061	2434.904	1185.877
	2016	0.479112	2676.647	1282.414
	2017	0.479112	2994.282	1434.597
	2018	0.479112	3280.054	1571.514
	2019	0.479112	3528.001	1690.309
	2020	0.479113	3736.52	1790.214
Fish at Fmsy	2015	0.487061	2434.904	1185.877
	2016	0.378494	2802.42	1060.700
	2017	0.378494	3404.081	1288.425
	2018	0.378494	3973.169	1503.822
	2019	0.378495	4475.215	1693.845
	2020	0.378495	4892.05	1851.615

No fishing	2015	0.487061	2434.904	1185.877
	2016	0.000479	3347.558	1.604147
	2017	0.000479	5449.536	2.612275
	2018	0.00048	7721.42	3.702541
	2019	0.00048	9646.361	4.627109
	2020	0.00048	10975.66	5.266487
Reduce F 25%	2015	0.487061	2434.904	1185.877
	2016	0.359334	2827.226	1015.918
	2017	0.359334	3487.824	1253.294
	2018	0.359334	4118.236	1479.823
	2019	0.359334	4675.441	1680.047
	2020	0.359335	5136.108	1845.582
Increase F 25%	2015	0.487061	2434.904	1185.877
	2016	0.59889	2536.298	1518.964
	2017	0.59889	2567.021	1537.363
	2018	0.59889	2592.882	1552.852
	2019	0.59889	2614.577	1565.845
	2020	0.598891	2632.725	1576.714

5.11.5 Reference points

Table 5.11.5.1. Norway lobster in GSAs 17 and 18. Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$		Not Defined	
	F_{MSYd}	0.388	SPiCT deterministic model estimates	This Report
	B_{MSYd}	6355 t	SPiCT deterministic model estimates	This Report

5.11.6 Data Deficiencies

EU DCF landings data prior to 2006 were not available for GSA 17 ITA. Data from Croatia (GSA 17) were available for 2013-2015 only. Discards data in GSA 17 ITA were available only for 2011.

5.12 SUMMARY SHEET OF DEEP-WATER ROSE SHRIMP IN GSA 1

Species common name: Deep-water rose shrimp

Species scientific name: *Parapenaeus longirostris*

Geographical Sub-area(s) GSA(s): 1

5.12.1 Stock development over time

State of the adult abundance and biomass

Biomass has fluctuated over the last 12 years and is currently near to the mean for the period. No precautionary biomass reference points have been proposed for the deep-water rose shrimp stock. Therefore, it is not possible to evaluate the status of the stock spawning biomass with respect to the precautionary approach.

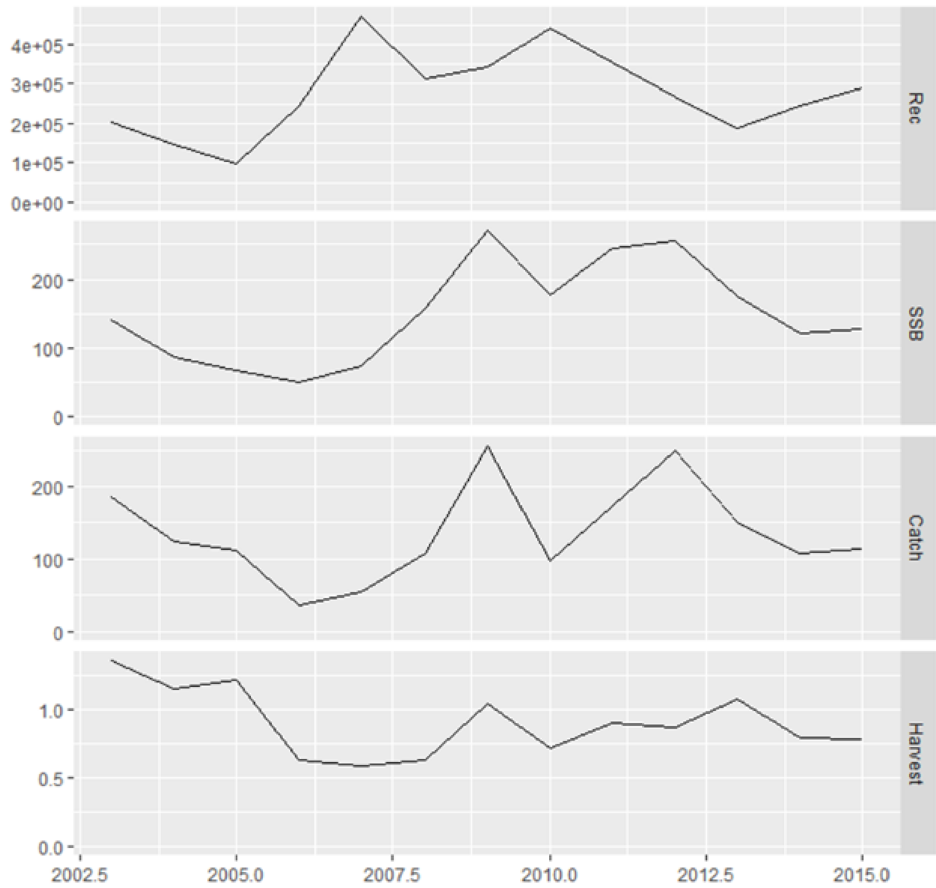


Figure 5.12.1.1. Deep-water rose shrimp in GSA 1. Model results for Recruitment, SSB(t), Catch(t) and Fishing mortality.

Table 5.12.1.1 Deep-water rose shrimp in GSA 01. XSA summary results. SSB and catch are in tons, recruitment in thousands of individuals.

	Recruitment	SSB (t)	Catch (t)	Fbar(1-3)

	(thousands)			
2003	201743	140.75	185.3	1.35
2004	146997	87.23	124.6	1.15
2005	98905	68.14	111.4	1.21
2006	246648	49.07	37.1	0.63
2007	472093	72.98	54.5	0.58
2008	313978	157.57	108.8	0.63
2009	345243	269.16	255.7	1.04
2010	441228	177.24	98.4	0.71
2011	355542	244.88	172.9	0.90
2012	267280	254.27	249.3	0.87
2013	189744	174.63	150.0	1.07
2014	245659	121.00	108.0	0.79
2015	290243	127.12	113.9	0.78

State of the juveniles (recruits)

From landing data, recruitment is indicated to have increased in the last two years, after a decrease from 2010 to 2013.
It is important to consider that recruitment or growth of this stock could be strongly driven by environmental and ecological factors (e.g. water temperature, predatory release effect) that can make difficult to predict the effect of fishing on the stock.

State of exploitation

According to the F estimates obtained using landing and discard data with XSA, F_{curr} was just below the estimated proxy value for FMSY of $F_{0.1}$=0.87. STECF-EWG 16-17 considers the stock has been harvested sustainably (fully exploited) consistent with high long term yield and lower risk of stock collapse.

5.12.2 Stock advice

STECF EWG 16-17 advises that when MSY considerations are applied the fishing mortality in 2017 should no more than F=0.87 this implies catches of no more than 138 tons.5.12.3

5.12.3 Basis of the assessment

An XSA analysis was performed using 2003-2015 DCF data (biomass landed and age composition of the catches), tuned with fishery independent abundance indices (MEDITS survey). A vector of natural mortality was obtained applying PRODBIOM. In addition, Yield per Recruit (YPR) analysis was performed for the estimation of F0.1 (i.e. proxy of FMSY).

5.12.4 Catch options

Short-term prediction results are shown in Table 5.2.4.1.

Table 5.12.4.1 Deep-water rose shrimp in GSA 1. Short term forecast in different F scenarios. Average (2013-15) weight at age, maturity at age and F at age. Recruitment (age 0) geomean (2013-15) (241882 thousand individuals), catch 2015 =113.9, catch 2016 132.99.

Rationale	Fbar	Catch 2017	Catch 2018	SSB 2017	SSB 2018	Change SSB 2017-2018(%)	Change Catch 2015-2017(%)
Zero catch	0	0	0	135.12	226.22	67.43	-100
High long term yield (F0.1)	0.87	137.94	126.66	135.12	127.00	-6.01	21.10
Status quo	0.87	138.23	126.81	135.12	126.82	-6.14	21.36
Different Scenarios	0.087	19.28	25.73	135.12	211.04	56.19	-83.07
	0.17	37.00	46.90	135.12	197.40	46.09	-67.51
	0.26	53.31	64.34	135.12	185.13	37.01	-53.19
	0.35	68.36	78.76	135.12	174.09	28.84	-39.99
	0.44	82.26	90.72	135.12	164.12	21.47	-27.78
	0.52	95.14	100.67	135.12	155.13	14.81	-16.47
	0.61	107.09	108.98	135.12	146.99	8.78	-5.98
	0.70	118.21	115.95	135.12	139.61	3.32	3.78
	0.78	128.56	121.82	135.12	132.91	-1.63	12.87
	0.96	147.28	131.06	135.12	121.27	-10.25	29.30
	1.05	155.76	134.71	135.12	116.20	-14.00	36.75
	1.13	163.73	137.87	135.12	111.57	-17.43	43.74
	1.22	171.23	140.63	135.12	107.32	-20.57	50.33
	1.31	178.30	143.05	135.12	103.42	-23.46	56.53
	1.39	184.98	145.19	135.12	99.83	-26.12	62.40
	1.48	191.30	147.11	135.12	96.51	-28.57	67.94
	1.57	197.29	148.84	135.12	93.45	-30.84	73.20
	1.65	202.98	150.41	135.12	90.61	-32.94	78.20
	1.74	208.39	151.85	135.12	87.98	-34.89	82.95

5.12.5 Reference points

Table 5.12.5.1. Deep-water rose shrimp in GSA 1. Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$			
	F_{MSY}	0.87	XSA assessment and YPR evaluation of FMSY Proxy (F0.1)	This Report

5.12.6 Data Deficiencies

Data from EU DCF as submitted through the official data call in 2016 were used. Length- frequencies distributions (LFD) were missing for the “métier” OTB_DWS. Missing LFDs were borrowed from other OTB segments. Catches age structure was also missing in the database. Biological parameters (growth parameters, sex-ratio) were not furnished for this species in GSA 1.

5.13 SUMMARY SHEET OF DEEP-WATER ROSE SHRIMP IN GSA 9

Species common name: Deep-water rose shrimp

Species scientific name: *Parapenaeus longirostris*

Geographical Sub-area(s) GSA(s): 9

5.13.1 Stock development over time

State of the adult abundance and biomass

According to the stock assessment, SSB estimates show an increasing trend with maximum value in 2015. No precautionary biomass reference points have been proposed for the deep-water rose shrimp stock. Therefore, the EWG is unable to fully evaluate the status of the spawning stock biomass with respect to the precautionary approach.

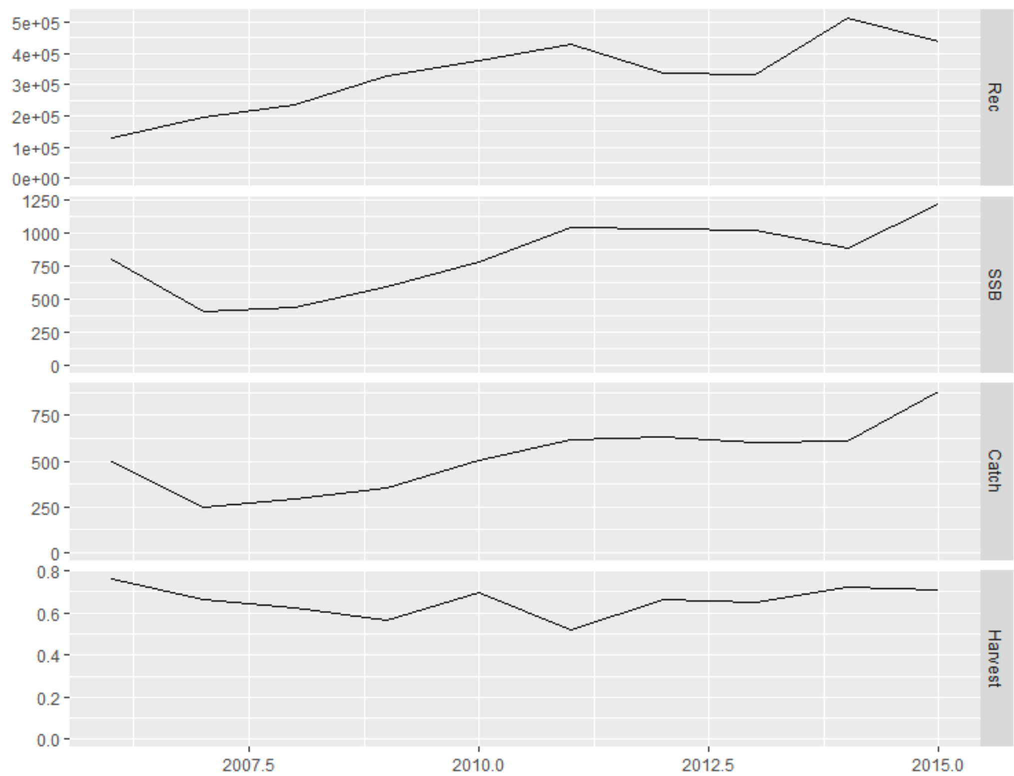


Figure 5.13.1.1. Deep-water rose shrimp in GSA 9. Model results recruitment, SSB (t), catch (t) and fishing mortality

Table 5.13.1.1. Deep-water rose shrimp in GSA 9. Model results recruitment, SSB (t), catch (t) and fishing mortality.

	Recruitment (thousands)	SSB (t)	Catch (t)	F_{bar0-2}

2006	129213	801.2	496	0.764
2007	194098	405.4	250	0.666
2008	233959	437.1	294	0.627
2009	329320	595.7	352	0.569
2010	376888	778.7	500	0.700
2011	430741	1040.7	614	0.523
2012	334733	1034.0	629	0.664
2013	332944	1021.5	606	0.653
2014	514047	881.0	606	0.724
2015	436771	1213.7	881	0.708

State of the juveniles (recruits)

From the assessment recruitment is indicated to have increased over the period 2006 to 2014 with the strongest year class observed in 2014 (514 millions).

It is important to consider that recruitment or growth of this stock could be strongly driven by environmental and ecological factors (e.g. water temperature, predatory release effect) that can make difficult to predict the effect of fishing on the stock.

State of exploitation

According to the F estimates obtained using landing and discard data with XSA, F_{curr} was just below the estimated reference value of $F_{0.1}$=0.71. STECF-EWG 16-17 considers the stock has been harvested sustainably (fully exploited) consistent with high long term yield and lower risk of stock collapse.

5.13.2 Stock advice

STECF EWG 16-17 advises that when MSY considerations are applied the fishing mortality in 2017 should no more than F=0.71 this implies catches of no more than 798 tons

5.13.3 Basis of the assessment

An XSA analysis was performed using 2006-2015 DCF data (biomass landed and age composition of the catches), tuned with fishery independent abundance indices (MEDITS survey). A vector of natural mortality was obtained applying PRODBIOM. In addition, Yield per Recruit (YPR) analysis was performed for the estimation of $F_{0.1}$ (i.e. proxy of F_{MSY}).

5.13.4 Catch options

Short-term prediction results are shown in the following Table (Table 5.13.4.1).

Table 5.13.4.1 Deep-water rose shrimp in GSA 09. Short term forecast in different F scenarios 3 year average (2013-15) weight at age, maturity at age and F at age. Recruitment (age 0) geomean 2013-15 (460566 thousand individuals), catch 2015=881, catch 2016=748.

Rationale	Ffactor	Fbar	Catch 2017	Catch 2018	SSB 2017	SSB 2018	Change SSB 2017-2018(%)	Change Catch 2015-2017(%)
Zero catch	0	0	0	0	1121	1978	76.5	-100.0
High long term yield (F0.1)	1.022	0.710	798	791	1121	1107	-1.2	-9.4
Status quo	1	0.695	788	786	1121	1118	-0.2	-10.6
Different Scenarios	0.2	0.139	218	290	1121	1731	54.4	-75.2
	0.3	0.209	313	400	1121	1625	45.0	-64.4
	0.4	0.278	400	491	1121	1530	36.5	-54.6
	0.5	0.348	479	566	1121	1443	28.8	-45.6
	0.6	0.417	551	628	1121	1365	21.8	-37.4
	0.7	0.487	618	680	1121	1295	15.5	-29.9
	0.8	0.556	679	722	1121	1230	9.8	-22.9
	0.9	0.626	735	757	1121	1172	4.5	-16.5
	1.1	0.765	836	810	1121	1069	-4.6	-5.1
	1.2	0.834	881	829	1121	1024	-8.6	-0.0
	1.3	0.904	922	844	1121	983	-12.3	4.7
	1.4	0.973	961	856	1121	944	-15.7	9.1
	1.5	1.043	997	866	1121	909	-18.9	13.2
	1.6	1.112	1031	874	1121	877	-21.8	17.1
	1.7	1.182	1063	880	1121	846	-24.5	20.7
	1.8	1.251	1093	884	1121	818	-27.0	24.1
	1.9	1.321	1121	887	1121	792	-29.3	27.3
	2	1.390	1147	889	1121	767	-31.5	30.3

5.13.5 Reference points

Table 5.13.5.1. Deep-water rose shrimp in GSA 9. Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$		Not Defined	
	$F_{0.1}$	0.71	XSA assessment and YPR evaluation of FMSY Proxy (F0.1)	This Report

5.13.6 Data Deficiencies

Data from EU DCF as submitted through the Official data call in 2016 were used. Length- frequencies distributions (LFD) were missing for the “métier” OTB_DWS. Missing LFDs were borrowed from other OTB segments. EU DCF data prior to 2006 were considered incomplete; therefore, they were not used for the stock assessment.

Discards data were missing for 2007 and 2008 as their collection was not compulsory. Discards for OTB those two years were estimated as the mean discard of the entire time-series. The LFD of OTB discards of 2009 were used to raise the discards. One set of biological parameters (growth parameters, sex-ratio) has been furnished for the period 2006-2015.

5.14 SUMMARY SHEET OF DEEP-WATER ROSE SHRIMP IN GSA 10

Species common name: Deep-water rose shrimp

Species scientific name: *Parapenaeus longirostris*

Geographical Sub-area(s) GSA(s): 10

5.14.1 Stock development over time

State of the adult abundance and biomass

The SSB shows a decreasing trend after the main peak in 2006 (624 t) remaining quite stable for the following years on an average value (2007-2011) of about 232 t until 2013 when the value of the SSB is the highest value among the more recent years. In the last two years the SSB decreases reaching the lower value of the time series (201 t).

State of the juveniles (recruits)

The recruitment shows a peak in 2005 equal to 587188 thousands individuals and after that year decreases until 2010 (190121 thousands) and then increase again until 2012 when reach an average value (2012-2015) of about 296297 thousands.

State of exploitation

The F_{bar} along the time series is on average 1.6, with a minimum of 1.2 in 2010 and a maximum of 2.25 in 2006. The current F (1.8) is larger than the F0.1 proxy for FMSY (0.9), which indicates that deep-water rose shrimp in GSA 10 is being fished above FMSY.

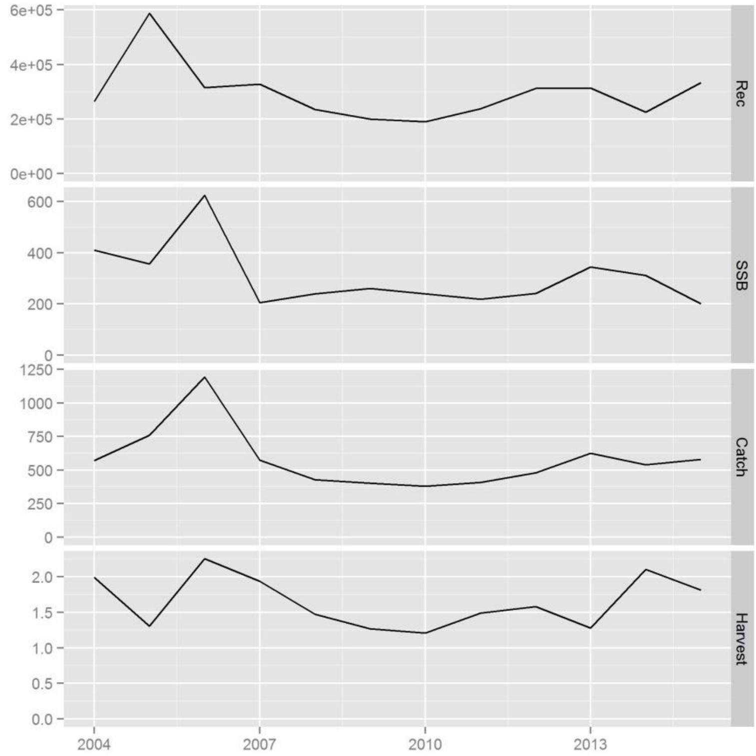


Figure 5.14.1-1. Deep-water rose shrimp in GSA 10. XSA results in terms of recruitment, SSB, Catches and fishing mortality.

Table 5.14.1-1. Deep-water rose shrimp in GSA 10. XSA results in terms of recruitment, SSB, Catches and fishing mortality.

Year	Rec (thousands)	SSB (t)	Catch (t)	Fbar (0-2)
2004	264866	410	571	1.99
2005	587188	356	760	1.30
2006	315289	624	1193	2.25
2007	327158	205	573	1.94
2008	235104	239	428	1.47
2009	200298	260	401	1.27
2010	190121	239	380	1.21
2011	237931	219	407	1.49
2012	312310	240	478	1.58
2013	314097	344	625	1.28
2014	225412	311	540	2.10
2015	333369	201	578	1.81

5.14.2 Stock advice

STECF EWG 16-17 advises that when MSY considerations are applied the fishing mortality in 2017 should no more than F=0.9 this implies catches of no more than 438 tons

5.14.3 Basis of the assessment

The stock assessment was performed applying an Extended Survivor Analysis (XSA) method calibrated with fishery independent survey abundance indices (MEDITS). In addition to give reference points, a yield-per-recruit (Y/R) analysis was carried out. Both methods were performed from the size composition of landings and discards, transforming length data to ages using slicing technique. Input data of age structure of landings and discards were taken from DCF. Von Bertalanffy growth parameters and length-weight relationship were taken from parameters estimated for deep-water rose shrimp in GSA 10. Natural mortality (vector) was estimated using PROBIOM.

5.14.4 Catch options

Catch options are summarized in the following Table 5.14.4.1.

Table 5.14.4.1. Short term forecast in different F scenarios computed for deep-water rose shrimp in GSA 10. Basis: F(2016) = mean(Fbar0-2 2013-2015)= 1.7; R(2016) = geometric mean of the recruitment of the last three years = 286850 (thousands); SSB(2015) = 200 t, Catch (2015)= 578 t.

Rationale	Ffactor	Fbar	Catch 2017	Catch 2018	SSB 2018	Change SSB 2017-2018(%)	Change Catch 2015-2017(%)
zero catch	0	0	0	0	730	189	-100
High long-term yield (F0.1)	0.53	0.9	438	536	382	51	-24
Status quo	1	1.7	648	648	254	0.3	12
Different scenarios	0.1	0.17	112	186	632	150	-81
	0.2	0.34	207	316	554	119	-64
	0.3	0.51	288	408	490	94	-50
	0.4	0.68	358	475	438	73	-38
	0.5	0.85	420	524	394	56	-27
	0.6	1.02	475	561	358	41	-18
	0.7	1.19	525	590	326	29	-9
	0.8	1.36	569	613	299	18	-1.6
	0.9	1.53	610	632	275	9	5
	1.1	1.86	683	662	235	-7	18
	1.2	2.03	715	675	217	-14	24
	1.3	2.20	745	687	202	-20	29
	1.4	2.37	774	697	188	-26	34
	1.5	2.54	801	707	175	-31	38
	1.6	2.71	826	717	163	-36	43
	1.7	2.88	850	726	152	-40	47
	1.8	3.05	872	734	141	-44	51
	1.9	3.22	894	743	132	-48	54
	2	3.39	914	751	123	-51	58

5.14.5 Reference points

Table 5.14.5.1. Deep-water rose shrimp in GSA 10. Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$		Not Defined	
	F_{MSY}	0.9	XSA assessment and YPR evaluation of FMSY Proxy (F0.1)	This Report

5.14.6 Data Deficiencies

No particular deficiencies have been found in the data submitted through DCF. Additional information can be found in section 6.14.

5.15 SUMMARY SHEET OF DEEP-WATER ROSE SHRIMP IN GSAs 9, 10 AND 11

Species common name: Deep-water rose shrimp

Species scientific name: *Parapenaeus longirostris*

Geographical Sub-area(s) GSA(s): 9 10 and 11

5.15.1 Stock development over time

State of the adult abundance and biomass

According to the assessment results, SSB estimates showed an increasing pattern in the period 2007-2011; then, the value remained quite stable oscillating around 1700 tons. In 2015 SSB was 1746.5 tons. No precautionary biomass reference points have been proposed for the deep-water rose shrimp stock. Therefore, STECF EWG 16-17 is unable to fully evaluate the status of the stock spawning biomass with respect to the precautionary approach.

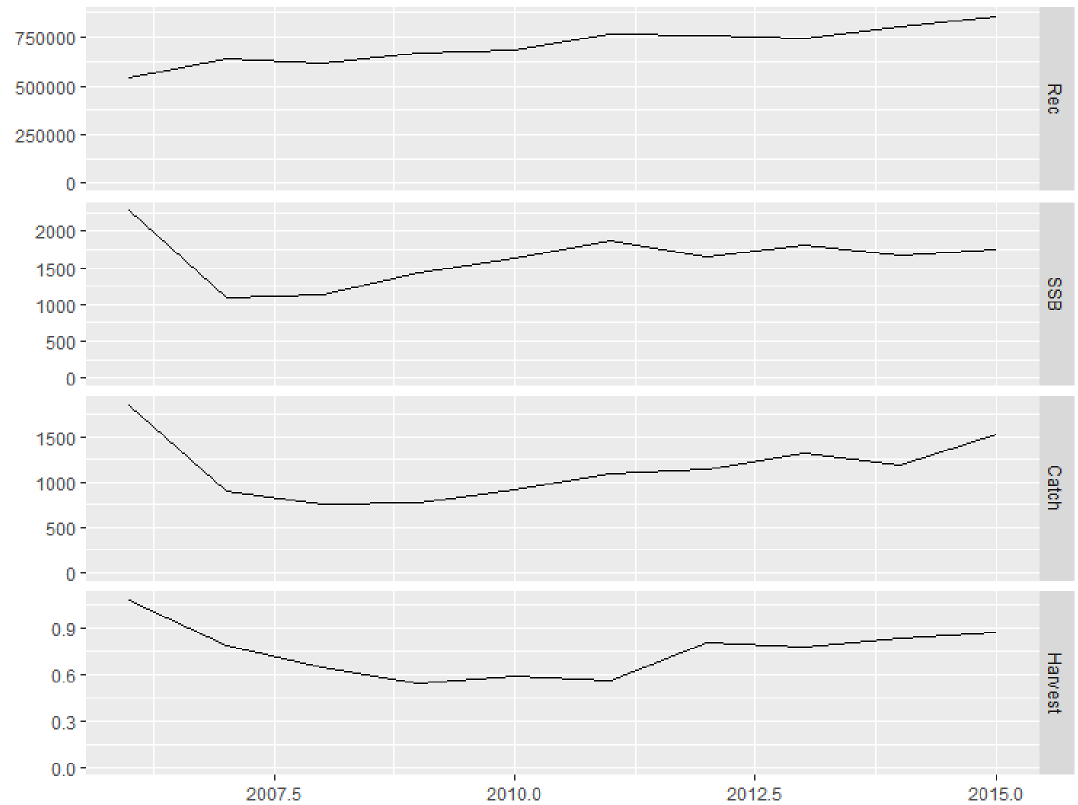


Figure 5.15.1.1. Deep-water rose shrimp in GSAs 9, 10, 11. Model results Recruitment, SSB (t), catch (t) and fishing mortality.

	Recruitment (thousands)	SSB (t)	Catch (t)	F_{bar0-2}
2006	543705	2279.4	1852.13	1.08
2007	635035	1102.2	895.64	0.78
2008	615391	1130.8	762.67	0.64
2009	667611	1437.7	763.92	0.54
2010	682102	1632.2	922.77	0.59
2011	763013	1875.5	1097.91	0.56
2012	754837	1643.8	1147.82	0.80
2013	744492	1813.4	1313.71	0.77
2014	805276	1672.5	1189.03	0.83
2015	858333	1746.5	1536.82	0.87

State of the juveniles (recruits)

The assessment shows an increasing trend in recruitment. It varies from a minimum of 543 million of individuals in 2006 to 858 million in 2015. The different parts of the combined area appear to be responding differently, survey data confirm this positive trend in GSA 9. In GSA 10, MEDITS relative indices for age 0 indicated a more fluctuating trend, with the highest recruitment peak in 2014 (964 millions). GSA 11 showed very low values in the last years; the maximum was observed in 2011 (286 millions).

It is important to consider that recruitment or growth of this stock could be strongly driven by environmental and ecological factors (e.g. water temperature, predatory release effect) that can make difficult to predict the effect of fishing on the stock.

State of exploitation

According to the F estimates from the assessment F_{curr} was below the estimated reference value of $F_{0.1}$=0.91 for all years with the exception of 2006. STECF-EWG 16-17 considers the stock has been harvested sustainably (fully exploited) consistent with high long term yield and lower risk of stock collapse.

5.15.2 Stock advice

STECF EWG 16-17 advises that when MSY considerations are applied the fishing mortality in 2017 should no more than F=0.91 this implies catches of no more than 1585.32 tons

In case management measures should be put in place, it is important to take into account the different fishing patterns observed by considering GSAs 9 and 10 separately. The fishing mortality exerted on the different age groups is quite different: in GSA 10 F is notably higher on 0 and 1 age groups, while in GSA 9 F is higher on ages 1, 2 and 3+. This is one of the main reasons explaining the different results observed in the assessments conducted separately on each GSA, where the species resulted overexploited in GSA 10 and fully exploited in GSA 09.

5.15.3 Basis of the assessment

An XSA analysis was performed using 2006-2015 DCF data (biomass caught and age composition of the catches), tuned with fishery independent abundance indices (MEDITS survey). A vector of natural mortality was obtained applying ProdBiom. In addition, Yield per Recruit (YPR) analysis was performed for the estimation of $F_{0.1}$ (i.e. proxy of F_{MSY}).

5.15.4 Catch options

Short-term prediction results are shown in the following Table (Table 5.15.4.1).

Table 5.15.4.1 Deep-water rose shrimp in GSAs 9, 10 and 11. Short term forecast in different F scenarios. The input parameters are from XSA stock assessment weight at age, maturity at age and F at age, averages 2013-15. Recruitment (age 0) geomean 2013-15 (801346 thousand individuals). F2016 status quo (F=0.82) gives catch 1435.38,

Rationale	Ffactor	Fbar	Catch 2017	Catch 2018	SSB 2017	SSB 2018	Change SSB 2017-2018(%)	Change Catch 2015-2017(%)
Zero catch	0	0	0	0	1674.64	3056.82	82.54	-100
High long term yield (F0.1)	1.102	0.91	1585.32	1544.60	1674.64	1601.99	-4.34	3.16
Status quo	1	0.82	1486.83	1489.91	1674.64	1683.23	0.51	-3.25
Different Scenarios	0.2	0.16	403.49	534.02	1674.64	2660.63	58.88	-73.74
	0.3	0.25	579.72	736.58	1674.64	2492.39	48.83	-62.28
	0.4	0.33	741.50	906.07	1674.64	2340.80	39.78	-51.75
	0.5	0.41	890.46	1048.27	1674.64	2203.80	31.60	-42.06
	0.6	0.49	1028.00	1167.94	1674.64	2079.63	24.18	-33.11

	0.7	0.58	1155.39	1269.00	1674.64	1966.74	17.44	-24.82
	0.8	0.66	1273.70	1354.66	1674.64	1863.80	11.30	-17.12
	0.9	0.74	1383.91	1427.57	1674.64	1769.63	5.67	-9.95
	1.1	0.90	1583.23	1543.48	1674.64	1603.71	-4.24	3.02
	1.2	0.99	1673.73	1589.78	1674.64	1530.30	-8.62	8.91
	1.3	1.07	1758.93	1630.01	1674.64	1462.34	-12.68	14.45
	1.4	1.15	1839.32	1665.19	1674.64	1399.23	-16.45	19.68
	1.5	1.23	1915.36	1696.16	1674.64	1340.47	-19.95	24.63
	1.6	1.32	1987.43	1723.61	1674.64	1285.61	-23.23	29.32
	1.7	1.40	2055.88	1748.12	1674.64	1234.25	-26.30	33.78
	1.8	1.48	2121.04	1770.15	1674.64	1186.06	-29.18	38.02
	1.9	1.56	2183.17	1790.11	1674.64	1140.72	-31.88	42.06
	2	1.64	2242.51	1808.33	1674.64	1097.98	-34.43	45.92

5.15.5 Reference points

Table 5.15.5.1. Deep-water rose shrimp in GSAs 9, 10, 11. Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$			
	F_{MSY}	0.91	XSA assessment and YPR evaluation of FMSY Proxy (F0.1)	This Report

5.15.6 Data Deficiencies

Data from EU DCF as submitted through the Official data call in 2016 were used. The time series of the demographic structures of landing were different according to the three GSAs: 2003-2015 for GSA 10, 2006-2015 for GSA 9 and 2009-2015 for GSA 11. Due to those differences, the analyses were carried out on the period 2006-2015. For the whole time series available (2009-2015) in GSA 11 the numbers at age were estimated from length distributions using the LFDA slicing method with DCF official parameters (sex combined), as the DCF official data on the age structure were found to be inconsistent with the provided growth parameters. An extrapolation of the data for the years 2006-2008 has been made for GSA 11, taking into account that the landing of deep-water rose shrimp in this area has a low weight in comparison to the other two GSAs. For the years 2006-2008, the age structures were reconstructed using an average of the distributions available for the years 2009-2011, proportionally to the landings.

Discards data in GSAs 9 and 10 were missing for 2007 and 2008 as their collection was not compulsory. Data available in the other years were used to raise the lacking ones (see methodology in the single assessments of the two GSAs). Discard was not available for GSA 11; however, this fraction was considered negligible.

One combined set of growth parameters has been furnished for GSA 11. This could affect the slicing of the length frequency distributions of the catches and MEDITS data as the species is characterised by significant differences in the growth rates between the two sexes.

5.16 SUMMARY SHEET OF COMMON SOLE IN GSA 7

Species common name: Common sole

Species scientific name: Solea solea

Geographical Sub-area(s) GSA(s): 7

5.16.1 Stock development over time

State of the adult abundance and biomass

Information is sparse with incomplete data and only four years that allow any analysis. SSB in the years 2011, 2013, 2014 and 2015, fluctuated between 215 and 361 tons the lowest value observed in 2015. Due to the short period studied, no precautionary biomass reference points have been proposed for this stock. As a result, EWG 16-17 is unable to evaluate the status of the stock spawning biomass in respect to these.

State of the juveniles (recruits)

Recruitment estimates are uncertain and show similar variability to SSB

State of exploitation

F mean values (Fcurrent) estimated from pseudocohort analyses show stable values in 2011, 2013 and 2014 (0.49-0.51) and an increase in 2015 (0.63). Preliminary estimates of F0.1=0.085, based on these results, the status of the stock of Common sole in GSA 7 would be exploited above FMSY. Length indicator analysis suggests exploitation is close to FMSY; however, this analysis does not take account of precautionary considerations. In conclusion it is likely that the stock is over exploited but the EWG cannot advise the magnitude of the over exploitation.

Table 5.16.1.1. Common sole in GSA7. Global VIT summary results evaluated separately by year

	Stock number (thousands)	Stock biomass (tons)	SSB (tons)	Fmean (1-4)
2011	4484	321.4	279.9	0.49
2013	5560	406.2	360.6	0.48
2014	4726	341.1	302.5	0.51
2015	4894	266.6	215.1	0.63

5.16.2 Stock advice

STECF EWG 16-17 advises that when MSY considerations are applied the fishing mortality in 2017 should be reduced however, the EWG is unable to estimate the extent of the reduction.

5.16.3 Basis of the assessment

Input data for the assessment were taken from DCF: OTB, GNS and GTR catch at length data for years: 2011, 2013, 2014 and 2015. No age data was reported in DCF. The values of M vector were calculated with PRODBIOM spread sheet. The analysis was carried out for the ages 0 to 5+ class. The Fmean used was 1-4. Slicing to transform length to age, Pseudocohort and Yield per Recruit analyses were performed using VIT software (FAO, 1997). OTB, GNS and GTR landings for the years 2011, 2013, 2014 and 2015 were used for analyses. These fleets represent more than 90% of the catch (OTB, 29%; GNS, 8%; GTR, 55%). No discards data of this fleet was reported.

5.16.4 Catch options

No catch options are provided for this stock.

5.16.5 Reference points

$F_{0.1}$ has been preliminary estimated as a ratio between Fcurrent and F0.1 (factor) estimated from Yield per Recruit analyses. $F_{0.1}$ = 0.08 in 2011, 2013, and $F_{0.1}$ = 0.09 in 2014, 2015.

$F_{0.1}$ = 0.085 is used as a preliminary estimate for this stock.

Table 5.16.5.1. Common sole in GSA 7. Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$		Not defined	
	F_{MSY}	0.085*	VIT assessment and YPR evaluation of FMSY Proxy (F0.1)	This Report

* preliminary value from limited years of data.

5.16.6 Data Deficiencies

1- There are not biological parameters defined for Common sole GSA 7 in DCF: no growth parameters, no length-weight relationship, no maturity data, no sex-ratio, etc. There are parameters for other Mediterranean GSA's but it would be necessary biological parameters for this species in GSA 7.

2- French landings data are available for a short period, 2011-2015, gear separately. It would be necessary to have a complete landing series at least for the main gears that catch Common sole (OTB, GNS, and GTR). 2012 landings data are missing for the main gear, GTR. No data about discards.

3- French length-frequencies are only available for the three main gears (OTB, GNS, and GTR) in years: 2011, 2013, 2014 and 2015. 2012 OTB length frequency is unreliable. Spanish length frequencies in GSA 7 are only available for OTB 2009 and 2010. There are not age frequencies in DCF.

4- French Effort data series in GSA 7 is limited to 2015 in DCF. During the EWG 16-17 has been submitted an additional series of French effort. Finally it has been available French effort data in GSA 7, gear separately, for the period 2013, 2014 and 2015. It is required a longer series of French effort data in GSA 7.

5- Data surveys don't cover adequately this species. MEDITS surveys catch Common sole occasionally and there is not possible to calculate abundance and biomass indices for Common sole in GSA 7.

5.17 SUMMARY SHEET OF GILTHEAD SEABREAM IN GSA 7

Species common name: Gilthead seabream

Species scientific name: *Sparus aurata*

Geographical Sub-area(s) GSA(s): 7

5.17.1 Stock development over time

The limited information on the gilthead seabream fishery in GSA 7 allowed a limited assessment of the status of the stock in 2013, 2014 and 2015, through pseudo-cohort analyses and length indicator. Landings in 2015 were much higher than those in the previous years, which might indicate under-reporting (lowest reported landings in 2014).

State of the adult abundance and biomass

SSB ranged between 860.8 t in 2014 and 2824.1 t in 2015. The available information does not allow assessing the SSB trend.

State of the juveniles (recruits)

Recruitment annual is not known.

State of exploitation

Based on the results of the pseudo-cohort analyses and length indicator analyses, gilthead seabream in GSA may be exploited well above FMSY.

5.17.2 Stock advice

STECF EWG 16-17 advises that when MSY considerations are applied the fishing mortality in 2017 should be reduced to no more than 50% of current F.

5.17.3 Basis of the assessment

Pseudo-cohort analysis performed with the most recent data (2015), using VIT software, and length indicator.

5.17.4 Catch options

No catch options are provided

5.17.5 Reference points

Using the pseudo-cohort analysis based on the most recent data (2015), which included the size structure of all fishing gears with reported gilthead catch, and taking $F_{0.1}$ as proxy for F_{MSY}, the reference point would be $F_{(0.1\text{-factor})}$ = 0.4, which corresponds to F=0.2. In 2015, F values were F_{mean}= 0.4 and $F_{(1-3)}$=0.5.

Table 5.17.5.1. Gilthead seabream in GSA 7. Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$		No Defined	
	F_{MSY}	0.19*	VIT assessment and YPR evaluation of FMSY Proxy (F0.1)	This Report

* Preliminary value from limited years of data.

5.17.6 Data Deficiencies

The information available on the gilthead seabream in GSA 7 was very limited. Main deficiencies regard data on the French fleets fishing effort, and data on landings and size structure, available only for the most recent years.

6 Data and Assessment by stock

The following ToRs are addressed by stock below

ToR: 1.1 Compile and provide the most updated information on stock identification, age and growth, maturity, feeding, habitat, and natural mortality.

ToR: 1.2 Compile and provide complete sets of annual data on landings and discards for the longest time series available up to and including 2015. This should be presented by fishing gear as well as by size/age structure.

ToR 1.3 Compile and provide complete sets of annual data on fishing effort for the longest time series available up to and including 2015. This should be described in terms of amount of vessels, time (days at sea, soaking time, or other relevant parameter) and fishing power (gear size, boat size, horse power, etc.) by Member State and fishing gear. Data shall be the most detailed possible to support the establishment of a fishing effort or capacity baseline

ToR 1.4 Compile and provide indices of abundances and biomass by year and size/age structure for the longest time series available up to and including 2015).

ToR 2 For the stocks given in Annex I-A, or combinations thereof, the STECF-EWG 16-17 is requested to:

ToR 2.1. Assess trends in fishing mortality, stock biomass, spawning stock biomass, and recruitment. Different assessment models should be applied as appropriate. Models should be compared using model diagnostics including retrospective analyses when the models can produce one. The selection of the most reliable assessment should be justified. Assumptions and uncertainties should be reported.

ToR 2.2. Propose and evaluate candidate MSY value, range of values and safeguard points in terms of fishing mortality and stock biomass. The proposed values shall be related to long-term high yields and low risk of stock/fishery collapse and ensure that the exploitation levels restore and maintain marine biological resources at least at levels which can produce the maximum sustainable yield.

ToR 2.3. Provide short and medium[1] term forecasts of spawning stock biomass, stock biomass and catches. The forecasts shall include different management scenarios, *inter alia*: zero catch, the status quo fishing mortality, and target to F_{MSY} or other appropriate proxy by 2018 and 2020 (by means of a proportional reduction of fishing mortality as from 2017). In particular, predict the level of fishing effort exerted by the different fleets which is commensurate with the short- and medium-term forecasts of the proposed scenarios. (1 Medium term forecast only when an acceptable stock-recruitment relationship is identifiable.)

ToR 2.4. Make any appropriate comments and recommendations to improve the quality of the assessments. Furthermore, advise on the ideal assessment frequency.

6.1 EUROPEAN SEABASS IN GSA 7

6.1.1 DATA GATHERING OF EUROPEAN SEABASS IN GSA 7

6.1.1.1 Stock Identity and Biology

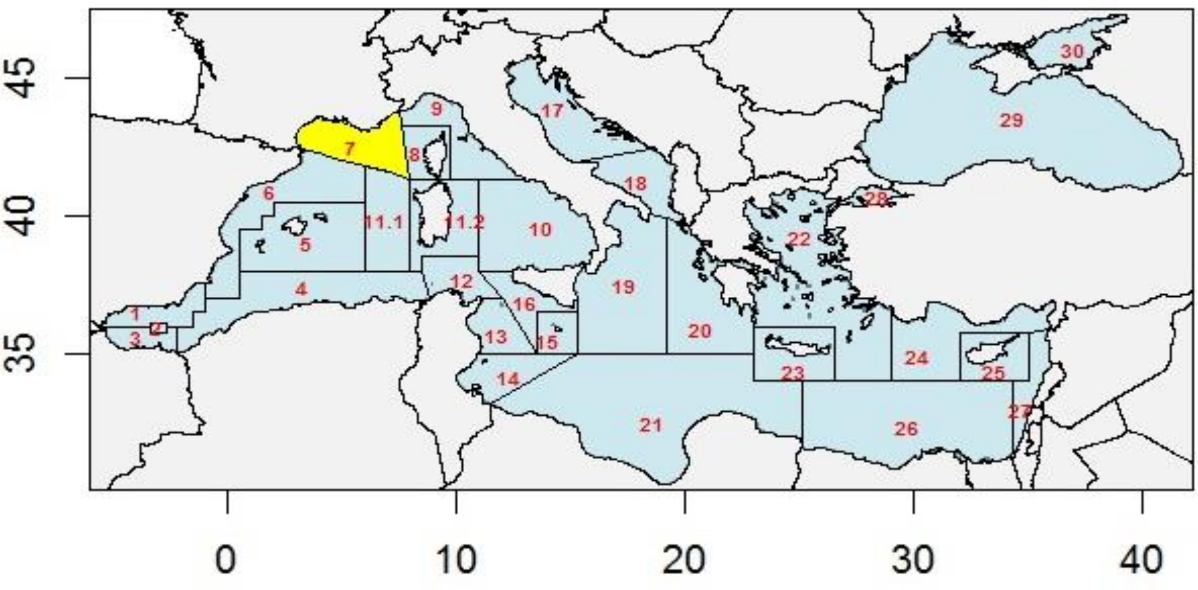


Figure 6.1.1.1.1. Geographical location of GSA 7

There is no information on stock units in the Mediterranean. Due to a lack of information about the structure of the seabass population in the western Mediterranean, this stock was assumed to be confined within the GSA 7 boundaries.

It is a marine species that also lives in brackish and freshwater, especially close to coastal lagoons and river mouths. It is a demersal species which is mainly found in a depth range 0 – 100m. It feeds mainly on fish and crustaceans and is ranked high in the trophic levels. Available information on the species is limited but suggests that females reach maturity at a length of about 35cm and males at a smaller size (25-30cm).

It was recorded for the species a maximum size of about 1 meter and a maximum reported lifespan of 30 years. Estimates of the von Bertalanffy growth parameters are available for different areas which show noticeable differences (6.1.1.1.1). Sea Bass have only one breeding season per year. This occurs in the winter for the Mediterranean population (December to March).

Table 6.1.1.1.1. European seabass in GSA 7. Growth in size parameters.

	Linf	k	t_0		
Gulf Lions	83.4	0.19		Females	(Fishbase)
Gulf Lions	57.5	0.33		Males	(Fishbase)
Sète	78.5	0.23	-0.05	Females	(Fishbase)
Sète	62.5	0.28	-0.16	Males	(Fishbase)
Morocco	105	0.09	-0.56	Combined	(Fishbase)
Tunisia	106	0.07		Combined	(Fishbase)
Algeria	71.3	0.21	-0.7	Combined	Apostolidis & Stergiou (2014)
Algeria	84.11	0.16	-0.86	Females	Apostolidis & Stergiou (2014)
Algeria	71.54	3.62	-0.79	Males	Apostolidis & Stergiou (2014)
Wales	84.65	0.077		Combined	Carroll (2014)

Table 6.1.1.1.2. European seabass in GSA 7. Length-weight relationship

a	b	sex
0.0157	2.884	Females
0.0262	2.734	Males

For the computations it was decided to use a set of parameters considered representative coming from the GSA7. The Linf parameter used is estimated for females in the Gulf of Lions and an average value for the K estimated in the same area for females and males. This choice was taken considering that the available information on sizes in the catch was not separated by sex and using such combination of parameters was assumed to limit the error in assignation of age from size, especially for the younger ages that constituted the bulk of the catches.

Natural mortality rates were estimated using two approaches: the Hoenig (1983) empirical equation based on life expectance: Ln(M)=1.44-0.982*Ln(Tmax) and the PRODBIOM approach (Abella et al, 1997): M=Ma+B/t. The Hoenig equation, assuming Tmax=30, provided a value of 0.148 while from the vector of M at age was derived also a value of 0.15 as the average value for ages 1 to 30. As juveniles of age class 0 are not present in the catch, a constant M value of 0.15 was hence used in the models.

6.1.1.2 Catch data

Information on annual data on landings is incomplete and consists of Spanish and French catches in GSA7.

Table 6.1.1.2.1. European seabass in GSA 7. Spanish catch by gear and year in GSA7

ESP BSS landings (tons)/fishing gear/year						
					Total	
year	GNS	GTR	LLS	**OTB**	ESP	%OTB
2002	0.07	0.02	0.03	**1.73**	1.85	93.5
2003	0.15	0.08	0.06	**1.89**	2.18	86.7
2004	0	0.05	0.02	**1.1**	1.17	94
2005	0.01	0.07	0.03	**1.24**	1.35	91.9
2006	0	0.01	0	**1.62**	1.63	99.4
2007	0.03	0	0.02	**1.02**	1.07	95.3
2008	0.05	0.01	0.19	**1.27**	1.52	83.6
2009	0.03	0	0.04	**1.18**	1.25	94.4
2010	0.01	0	0.04	**0.19**	0.24	79.2
2011					0	
2012						
2013						
2014					0	
2015					0	

Table 6.1.1.2.1. European seabass in GSA 7. French catch by gear and year in GSA7

Part 1 (France)

year	N/I	DRB	FPO	**FYK**	GND	**GNS**	**GTR**	LHP
2002								

2003								
2004								
2005								
2006								
2007								
2008								
2009						**27.7**		
2010						**123.4**	**123.4**	
2011				**24.3**		**198.6**		
2012						**144.8**		
2013	1.4		19	**22.4**		**136.8**	**61.6**	9
2014	50.1		0	**21.1**		**68.6**	**36.6**	5.8
2015	51.3	0.03	2.7	**25.3**	4.2	**83.3**	**61.8**	7.9

Part 2 (France)

year	LLD	**LLS**	LTL	**OTB**	OTM	OTT	PS	SB	Total FRA
2002				**167.6**					167.6
2003				**144.7**					144.7
2004				**167.5**					167.5
2005				**187.2**					187.2
2006				**206.9**					206.9
2007				**202.6**					202.6
2008				**157.3**					157.3
2009		**3**		**112.3**					143
2010		**3**		**71.9**					321.7
2011		**29.6**		**43.8**					296.3
2012		**25.3**							170
2013		**30**		**25.1**			0	0.6	306.1
2014		**23.6**		**20.1**	0.3	1.2	3.6		230.9
2015	0.9	**17.4**	0.02	**13.4**	0.3	0.7	1.7	1	272

Figure 6.1.1.2.1. European seabass in GSA 7. Spanish catch by gear and year in GSA7

It is evident that most of the catches are taken by France. In fact, even though part of the Spanish fleet operates in GSA7, it concentrates effort in deeper waters where the seabass is not frequently found.

Table 6.1.1.2.2. European seabass in GSA 7. Total landings by country and year

European Seabass, Total landings (tons)/year				
year	ESP	FRA	Total (ESP+FRA)	% FRA
2002	1.9	167.6	169.4	98.9
2003	2.2	144.7	146.9	98.5
2004	1.2	167.5	168.7	99.3
2005	1.4	187.2	188.6	99.3
2006	1.6	206.9	208.6	99.2

2007	1.1	202.6	203.7	99.5
2008	1.5	157.3	158.8	99
2009	1.3	143	144.2	99.1
2010	0.2	321.7	321.9	99.9
2011	0	296.3	296.3	100
2012		170	170	100
2013		306.1	306.1	100
2014	0	230.9	230.9	100
2015	0	272	272	100

Size distribution data by métier is only available for France. Only for the most recent years (2013-2015) is the catch composition complete for all the gears.

Table 6.1.1.2.3. European seabass in GSA 7. Size distribution of the catches by gear and year.

				Boat dredge	Pots and Traps						Fyke nets			Driftnet					Set gillnet			
length class	-1.00			DRB	FPO						FYK			GND					GNS			
	2013	2014	2015	2015	2013	2014	2015		2011	2012	2013	2014	2015	2015		2009	2010	2011	2012	2013	2014	2015
15.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
16.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
17.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
18.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
19.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
20.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
21.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
22.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.07	0.00	0.00
23.00	0.00		0.00	0.00	0.05	0.00	0.00		0.00		0.06		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
24.00	0.00		0.19	0.00	0.05	0.00	0.01		0.00		0.06		0.09	0.02		0.00	0.00	0.00	0.00	0.00	0.00	0.00
25.00	0.05		0.00	0.00	0.63	0.00	0.00		0.00		0.75		0.00	0.00		0.00	0.00	1.76	0.00	0.08	0.00	0.30
26.00	0.04		0.00	0.00	0.49	0.00	0.00		0.00		0.57		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	1.49
27.00	0.03		0.37	0.00	0.34	0.00	0.02		0.00		0.40		0.18	0.03		0.00	0.00	0.88	0.00	0.24	0.26	0.30
28.00	0.00		0.19	0.00	0.05	0.00	0.01		1.45		0.06		0.09	0.02		0.00	0.00	4.11	0.41	0.32	0.39	0.60
29.00	0.00		0.19	0.00	0.05	0.00	0.01		2.90		0.06		0.09	0.02		0.00	0.00	2.03	0.42	0.73	0.26	0.00
30.00	0.01		0.19	0.00	0.15	0.00	0.01		0.00		0.17		0.09	0.02		0.00	0.01	7.17	1.26	3.07	0.26	0.00
31.00	0.01		0.93	0.00	0.10	0.00	0.05		7.25		0.12		0.46	0.08		0.00	0.01	3.83	6.71	2.41	0.39	0.89
32.00	0.02		1.68	0.00	0.24	0.00	0.09		5.80		0.29		0.83	0.14		0.00	0.01	7.99	6.28	1.99	0.13	0.89
33.00	0.01		2.61	0.00	0.15	0.00	0.14		4.35		0.17		1.29	0.22		0.01	0.02	13.17	7.96	2.53	0.78	0.30
34.00	0.04		2.24	0.00	0.49	0.00	0.12		7.25		0.57		1.10	0.18		0.01	0.02	11.22	5.41	1.80	1.56	1.79
35.00	0.06		2.05	0.00	0.78	0.00	0.11		1.45		0.92		1.01	0.17		0.01	0.01	22.41	10.55	1.54	1.56	4.17
36.00	0.08		1.68	0.00	1.02	0.00	0.09		5.80		1.21		0.83	0.14		0.00	0.01	18.19	12.58	1.70	1.17	3.28
37.00	0.06		3.54	0.00	0.83	0.00	0.19		5.80		0.98		1.75	0.29		0.01	0.01	31.89	12.54	2.09	2.74	3.28
38.00	0.13		1.68	0.00	1.75	0.00	0.09		2.90		2.07		0.83	0.14		0.01	0.02	33.77	16.23	3.15	3.65	5.07
39.00	0.11		1.31	0.00	1.46	0.00	0.07		0.00		1.72		0.64	0.11		0.01	0.02	22.37	9.60	2.42	2.35	5.37
40.00	0.11		0.75	0.00	1.41	0.00	0.04		0.00		1.66		0.37	0.06		0.01	0.01	38.12	12.54	4.87	2.74	3.87
41.00	0.08		1.49	0.00	1.07	0.00	0.08		0.00		1.26		0.74	0.12		0.01	0.01	14.55	5.47	2.91	1.69	3.28
42.00	0.08		0.93	0.00	1.12	0.00	0.05		0.00		1.32		0.46	0.08		0.00	0.01	15.29	4.94	3.92	1.43	2.09
43.00	0.09		1.31	0.00	1.26	0.00	0.07		0.00		1.49		0.64	0.11		0.01	0.00	15.09	8.44	2.75	1.56	2.38
44.00	0.07		0.37	0.00	0.92	0.00	0.02		0.00		1.09		0.18	0.03		0.01	0.01	11.13	5.35	1.97	1.17	2.09
45.00	0.07		0.56	0.00	0.92	0.00	0.03		0.00		1.09		0.28	0.05		0.01	0.01	7.24	4.21	2.18	0.78	0.89
46.00	0.08		0.93	0.00	1.12	0.00	0.05		0.00		1.32		0.46	0.08		0.01	0.01	1.89	4.08	1.62	0.78	0.60
47.00	0.02		0.56	0.00	0.24	0.00	0.03		0.00		0.29		0.28	0.05		0.01	0.01	2.85	2.02	1.38	1.30	0.60
48.00	0.03		0.56	0.00	0.39	0.00	0.03		0.00		0.46		0.28	0.05		0.00	0.01	3.78	1.65	0.69	1.56	1.49
49.00	0.02		0.19	0.00	0.19	0.00	0.01		0.00		0.23		0.09	0.02		0.00	0.00	1.76	1.99	0.84	0.65	1.19
50.00	0.02		1.87	0.00	0.19	0.00	0.10		0.00		0.23		0.92	0.15		0.00	0.00	1.76	2.42	0.38	0.65	0.89
51.00	0.02		1.49	0.00	0.24	0.00	0.08		0.00		0.29		0.74	0.12		0.00	0.00	0.00	0.39	0.61	0.65	0.60
52.00	0.00		0.93	0.00	0.05	0.00	0.05		0.00		0.06		0.46	0.08		0.00	0.00	0.00	1.98	0.07	1.04	1.79
53.00	0.02		0.56	0.00	0.19	0.00	0.03		0.00		0.23		0.28	0.05		0.00	0.00	0.88	0.39	0.38	0.26	0.60
54.00	0.01		0.56	0.00	0.15	0.00	0.03		0.00		0.17		0.28	0.05		0.00	0.00	0.00	0.41	0.23	0.00	0.89
55.00	0.02		0.56	0.00	0.19	0.00	0.03		1.45		0.23		0.28	0.05		0.00	0.00	0.94	1.21	0.38	0.26	1.19
56.00	0.02		0.00	0.00	0.19	0.00	0.00		0.00		0.23		0.00	0.00		0.00	0.00	0.00	0.81	0.08	0.13	0.00
57.00	0.00		0.00	0.00	0.05	0.00	0.00		0.00		0.06		0.00	0.00		0.00	0.00	0.88	1.19	0.23	0.26	0.60
58.00	0.01		0.75	0.00	0.10	0.00	0.04		0.00		0.12		0.37	0.06		0.00	0.00	0.88	0.77	0.00	0.13	0.60
59.00	0.02		0.00	0.00	0.19	0.00	0.00		0.00		0.23		0.00	0.00		0.00	0.00	0.00	0.83	0.30	0.13	0.30
60.00	0.02		0.19	0.00	0.24	0.00	0.01		1.45		0.29		0.09	0.02		0.00	0.00	1.76	2.47	0.31	0.26	0.00
61.00	0.02		0.00	0.00	0.29	0.00	0.00		0.00		0.34		0.00	0.00		0.00	0.00	0.88	0.80	0.00	0.00	0.00
62.00	0.01		0.19	0.00	0.10	0.00	0.01		0.00		0.12		0.09	0.02		0.00	0.00	0.00	0.42	0.00	0.26	0.00
63.00	0.00		0.00	0.00	0.05	0.00	0.00		0.00		0.06		0.00	0.00		0.00	0.00	0.00	0.39	0.22	0.00	0.30
64.00	0.01		0.00	0.00	0.10	0.00	0.00		0.00		0.12		0.00	0.00		0.00	0.00	0.88	0.78	0.07	0.00	0.00
65.00	0.01		0.19	0.00	0.10	0.00	0.01		0.00		0.12		0.09	0.02		0.00	0.00	0.00	1.19	0.07	0.26	0.00
66.00	0.01		0.00	0.00	0.15	0.00	0.00		0.00		0.17		0.00	0.00		0.00	0.00	0.00	0.00	0.07	0.26	0.00
67.00	0.00		0.00	0.00	0.05	0.00	0.00		0.00		0.06		0.00	0.00		0.00	0.00	0.00	0.39	0.07	0.13	0.00
68.00	0.01		0.00	0.00	0.10	0.00	0.00		0.00		0.12		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.26	0.00
69.00	0.00		0.00	0.00	0.05	0.00	0.00		0.00		0.06		0.00	0.00		0.00	0.00	0.00	1.19	0.07	0.26	0.00
70.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.88	0.00	0.00	0.26	0.00
71.00	0.01		0.00	0.00	0.10	0.00	0.00		0.00		0.12		0.00	0.00		0.00	0.00	0.00	0.00	0.07	0.13	0.00
72.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
73.00	0.00		0.00	0.00	0.05	0.00	0.00		0.00		0.06		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.26	0.00
74.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
75.00	0.01		0.00	0.00	0.10	0.00	0.00		0.00		0.12		0.00	0.00		0.00	0.00	0.00	0.00	0.07	0.13	0.00
76.00	0.00		0.19	0.00	0.05	0.00	0.01		0.00		0.06		0.09	0.02		0.00	0.00	0.00	0.00	0.00	0.00	0.00
77.00	0.00		0.00	0.00	0.05	0.00	0.00		0.00		0.06		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
78.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
79.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
80.00	0.00		0.00	0.00	0.05	0.00	0.00		0.00		0.06		0.00	0.00		0.00	0.00	0.00	0.39	0.30	0.00	0.00
81.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
82.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
83.00	0.00		0.56	0.00	0.00	0.00	0.03		0.00		0.00		0.28	0.05		0.00	0.00	0.00	0.00	0.00	0.00	0.00
84.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
85.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.00	0.39	0.00	0.13	0.00
86.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
87.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.88	0.39	0.00	0.00	0.00
88.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
89.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
90.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.00	0.39	0.00	0.00	0.00
91.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
92.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.00	0.39	0.00	0.00	0.00
93.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
94.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
95.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
96.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
97.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
98.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
99.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
100.00	0.00		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00

Part 1

	Trammel net								Set longlines				
length class	GTR								LLS				
	2010	2011	2012	2013	2014	2015	2009	2010	2011	2012	2013	2014	2015
15.00	0			0	0	0	0	0	0	0	0	0	0
16.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00
20.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00
21.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00
22.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00
23.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00
24.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00
25.00	0.00			0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26.00	0.00			0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.06	0.00	0.00
27.00	0.00			0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00
28.00	0.00			0.00	0.12	0.00	0.00	0.00	0.00	0.17	0.17	0.00	0.00
29.00	0.00			0.06	0.24	0.00	0.00	0.00	0.00	0.33	0.12	0.00	0.04
30.00	0.00			0.00	0.20	0.00	0.00	0.00	0.00	0.32	0.17	0.00	0.02
31.00	0.01			0.00	0.20	0.66	0.00	0.00	0.00	0.50	0.23	0.00	0.03
32.00	0.01			0.01	0.31	0.00	0.00	0.00	0.00	0.35	0.23	0.00	0.00
33.00	0.01			0.13	0.39	0.88	0.00	0.00	0.00	1.34	0.06	0.00	0.03
34.00	0.01			0.07	0.78	1.10	0.00	0.00	0.00	0.87	0.17	0.00	0.05
35.00	0.01			0.08	0.75	1.54	0.00	0.00	0.50	0.65	0.06	0.03	0.03
36.00	0.01			0.29	1.02	1.54	0.00	0.00	0.75	1.39	0.06	0.05	0.01
37.00	0.01			0.47	0.86	2.87	0.00	0.00	0.25	0.86	0.17	0.00	0.05
38.00	0.01			0.63	0.82	1.76	0.00	0.00	1.26	1.57	0.06	0.05	0.04
39.00	0.01			0.56	0.78	1.54	0.00	0.00	1.26	0.86	0.06	0.13	0.02
40.00	0.02			0.76	0.47	1.32	0.00	0.00	0.75	0.83	0.12	0.05	0.08
41.00	0.01			0.29	0.86	1.10	0.00	0.00	1.01	1.21	0.17	0.00	0.04
42.00	0.01			0.35	0.51	0.66	0.00	0.00	1.76	0.84	0.06	0.08	0.05
43.00	0.00			0.48	0.55	1.32	0.00	0.00	0.75	1.04	0.00	0.13	0.03
44.00	0.01			0.09	0.59	1.32	0.00	0.00	0.50	0.86	0.06	0.00	0.09
45.00	0.00			0.55	0.86	1.10	0.01	0.00	0.75	2.07	0.29	0.08	0.06
46.00	0.00			0.42	0.98	0.22	0.01	0.00	0.75	1.03	0.23	0.13	0.04
47.00	0.00			0.33	0.39	0.88	0.01	0.00	1.01	0.68	0.00	0.05	0.08
48.00	0.00			0.27	0.43	1.32	0.01	0.00	1.01	0.52	0.06	0.18	0.09
49.00	0.00			0.53	0.24	1.54	0.01	0.00	0.50	0.33	0.12	0.10	0.10
50.00	0.00			0.27	0.35	0.88	0.01	0.00	0.75	0.51	0.06	0.05	0.06
51.00	0.00			0.20	0.04	0.22	0.00	0.00	0.25	0.50	0.17	0.21	0.02
52.00	0.00			0.32	0.12	0.00	0.00	0.00	1.01	0.68	0.00	0.10	0.07
53.00	0.00			0.27	0.08	0.44	0.01	0.00	0.50	0.18	0.17	0.05	0.05
54.00	0.00			0.26	0.12	0.44	0.00	0.00	0.25	0.17	0.12	0.15	0.02
55.00	0.00			0.14	0.04	0.00	0.01	0.00	1.01	0.16	0.06	0.28	0.02
56.00	0.00			0.07	0.00	0.22	0.01	0.00	0.50	0.00	0.00	0.21	0.04
57.00	0.00			0.26	0.08	0.00	0.01	0.00	0.25	0.34	0.06	0.08	0.02
58.00	0.00			0.39	0.08	0.00	0.01	0.00	0.75	0.00	0.06	0.05	0.02
59.00	0.00			0.40	0.16	0.22	0.00	0.00	0.25	0.16	0.17	0.13	0.03
60.00	0.00			0.40	0.00	0.44	0.00	0.00	1.01	0.00	0.00	0.15	0.01
61.00	0.00			0.20	0.00	0.22	0.01	0.00	0.75	0.16	0.00	0.05	0.02
62.00	0.00			0.26	0.04	0.00	0.00	0.00	0.25	0.16	0.00	0.00	0.02
63.00	0.00			0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.02
64.00	0.00			0.19	0.08	0.00	0.00	0.00	0.25	0.00	0.12	0.03	0.02
65.00	0.00			0.00	0.00	0.00	0.00	0.00	1.01	0.00	0.00	0.05	0.01
66.00	0.00			0.13	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.02
67.00	0.00			0.39	0.00	0.00	0.00	0.00	0.25	0.16	0.06	0.00	0.00
68.00	0.00			0.00	0.00	0.00	0.00	0.00	0.25	0.18	0.00	0.00	0.00
69.00	0.00			0.13	0.00	0.00	0.00	0.00	0.25	0.16	0.06	0.00	0.01
70.00	0.00			0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00
71.00	0.00			0.13	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.01
72.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.06	0.00	0.00
73.00	0.00			0.06	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00
74.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
75.00	0.00			0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00
76.00	0.00			0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
77.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
78.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
79.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
80.00	0.00			0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
81.00	0.00			0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00
82.00	0.00			0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00
83.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
84.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
85.00	0.00			0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00
86.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
87.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
88.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
89.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
91.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
92.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
93.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
94.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
95.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
96.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
97.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
98.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
99.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

length	Bottom otter trawl													
FRA	OTB, number of individuals (thousands)													
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
15	0	0	0	0	0	0	0	0	0	0		0	0	0
16.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
17.00	0.00	0.00	0.00	0.00	1.33	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
18.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
19.00	1.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00		0.00	0.00	0.00
21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
22.00	1.56	0.00	0.00	0.54	0.00	0.00	0.00	0.00	1.24	0.01		0.00	0.00	0.00
23.00	1.56	1.04	0.00	4.29	0.00	0.00	0.00	0.00	0.53	0.04		0.00	0.00	0.00
24.00	1.56	0.00	0.00	3.76	0.00	0.00	0.00	0.00	4.12	0.07		0.00	0.00	0.00
25.00	7.81	5.77	0.00	3.22	0.00	0.00	1.08	0.00	5.49	0.10		0.00	0.00	0.00
26.00	6.25	10.35	0.00	3.19	0.00	2.60	3.17	0.13	6.56	0.18		0.09	0.00	0.00
27.00	4.69	12.57	1.06	2.60	1.40	3.91	9.79	0.42	12.17	0.50		0.00	0.00	0.00
28.00	3.13	12.23	1.67	10.90	4.36	4.97	13.06	0.67	15.06	0.91		0.18	0.00	0.12
29.00	2.46	15.49	6.28	15.98	14.06	3.93	16.69	1.50	14.49	2.64		0.35	0.08	0.00
30.00	3.98	8.89	7.09	29.62	19.91	8.70	11.58	0.94	10.36	2.25		0.69	0.75	0.06
31.00	2.41	9.80	16.70	31.90	37.64	21.40	10.49	2.67	8.50	4.06		1.14	0.83	0.13
32.00	4.99	6.55	18.70	22.39	31.77	27.60	14.43	5.53	7.10	4.76		1.83	0.91	0.07
33.00	9.75	6.45	17.32	15.37	30.93	29.17	11.52	5.60	5.68	4.61		2.00	1.00	0.63
34.00	13.25	5.60	18.00	12.51	22.68	41.45	11.79	5.39	6.42	3.53		3.57	0.91	0.81
35.00	21.27	6.42	19.35	13.79	17.30	37.55	15.23	4.60	4.17	3.99		4.79	1.00	0.69
36.00	17.67	8.09	16.23	23.75	12.94	21.05	16.65	4.82	4.10	3.16		3.05	1.41	0.62
37.00	14.63	8.63	16.15	10.18	19.12	7.92	8.14	7.02	2.45	3.37		4.17	0.91	0.45
38.00	11.63	6.28	15.18	9.94	12.64	8.24	14.37	97.25	1.66	1.74		2.35	1.16	0.80
39.00	13.82	7.71	12.13	10.00	9.62	7.99	5.21	3.34	1.74	2.60		2.78	0.81	0.44
40.00	9.22	10.55	5.93	7.64	10.74	9.34	5.11	185.82	2.17	2.01		2.00	1.44	0.49
41.00	7.11	5.34	11.47	4.72	10.44	10.32	5.07	321.03	1.32	2.17		1.57	0.33	0.07
42.00	7.42	4.85	6.02	7.05	10.23	7.36	2.69	186.46	1.99	1.48		1.22	0.58	0.19
43.00	5.37	4.24	6.82	5.50	7.42	11.19	6.34	231.49	0.90	0.72		1.39	1.36	0.01
44.00	6.13	5.35	3.55	4.97	10.45	9.71	4.78	350.97	1.21	1.04		0.69	0.58	0.37
45.00	5.22	4.27	3.97	1.61	5.06	2.68	3.78	108.49	1.08	0.34		0.44	0.17	0.25
46.00	3.61	4.14	1.96	1.36	4.67	5.64	2.63	122.98	1.02	0.91		0.18	0.41	0.25
47.00	3.52	2.22	4.01	1.26	3.48	3.51	2.42	125.98	0.79	0.90		0.27	0.08	0.13
48.00	4.11	3.08	2.50	1.10	1.17	3.02	4.28	123.25	1.07	0.51		0.18	0.94	0.13
49.00	2.28	1.70	2.61	1.57	2.52	0.39	2.19	154.79	0.21	0.49		0.52	3.08	0.12
50.00	2.91	2.10	1.25	0.67	1.85	3.54	0.65	62.89	0.81	0.47		0.09	0.64	0.26
51.00	3.14	3.12	3.68	4.82	1.27	3.01	2.95	62.19	0.15	0.30		0.09	0.08	0.25
52.00	1.54	2.80	2.33	0.73	1.81	0.12	4.32	61.95	1.08	0.81		0.27	0.55	0.01
53.00	1.11	2.30	2.26	0.48	1.11	3.74	1.58	3.37	2.47	0.29		0.27	0.94	0.13
54.00	1.05	1.61	1.21	0.26	1.95	0.56	2.86	0.84	0.59	0.55		0.44	0.08	0.13
55.00	0.32	1.31	1.90	0.48	0.53	1.29	0.61	3.24	0.78	0.32		0.18	0.94	0.13
56.00	1.67	1.00	1.74	0.73	2.00	0.94	0.67	6.59	0.89	0.33		0.00	0.00	0.00
57.00	2.49	1.51	0.81	5.09	2.12	2.07	2.35	7.99	1.14	0.39		0.18	1.89	0.06
58.00	1.91	2.89	0.00	0.00	1.69	1.98	0.92	2.59	0.24	0.35		0.18	0.94	0.01
59.00	0.87	0.96	0.92	1.68	0.50	0.56	0.30	1.91	0.08	0.21		0.00	0.00	0.06
60.00	1.63	1.03	1.78	0.99	0.82	0.65	2.00	1.56	0.22	0.39		0.00	0.00	0.00
61.00	1.81	0.98	0.57	5.81	0.38	0.48	1.05	2.05	1.26	0.11		0.00	0.47	0.18
62.00	0.60	0.26	0.15	1.35	0.79	0.69	0.01	2.60	0.16	0.15		0.00	0.00	0.06
63.00	0.81	0.86	0.19	0.45	0.43	0.33	1.69	1.22	0.08	0.16		0.27	0.00	0.06
64.00	0.34	0.13	0.65	1.67	0.51	0.74	0.78	0.61	0.13	0.09		0.00	0.00	0.06
65.00	0.40	1.07	0.25	2.03	1.02	0.68	0.23	1.78	0.12	0.06		0.27	0.00	0.00
66.00	0.00	1.13	0.18	0.00	0.15	0.26	1.10	0.00	0.94	0.15		0.09	0.00	0.00
67.00	0.20	0.23	1.00	0.00	0.14	0.22	0.16	0.56	0.00	0.05		0.09	0.00	0.06
68.00	0.59	0.07	0.00	0.64	0.47	0.79	0.70	1.13	0.08	0.09		0.00	0.00	0.12
69.00	0.73	0.28	0.00	0.23	0.35	0.49	0.14	0.73	0.27	0.05		0.09	0.00	0.00
70.00	0.00	1.10	0.78	0.00	1.10	0.33	0.33	0.95	0.21	0.43		0.09	0.47	0.06
71.00	0.20	0.22	0.00	0.27	0.06	0.17	0.00	0.20	0.15	0.04		0.00	0.00	0.06
72.00	0.34	0.27	0.00	0.00	0.58	0.41	0.22	0.86	0.03	0.05		0.09	0.00	0.00
73.00	0.40	0.14	0.57	0.22	0.34	0.00	0.15	0.16	0.01	0.21		0.00	0.94	0.12
74.00	0.53	0.13	0.40	1.96	0.18	0.00	0.10	0.06	0.27	0.22		0.09	0.00	0.12
75.00	0.74	0.26	0.00	0.25	0.36	0.00	0.24	0.18	0.08	0.00		0.35	0.00	0.06
76.00	0.00	0.00	0.00	0.00	0.51	0.00	0.00	0.07	0.00	0.04		0.00	0.00	0.00
77.00	0.00	0.19	0.00	0.00	0.32	0.25	0.18	0.45	0.17	0.17		0.00	0.00	0.00
78.00	0.29	0.00	0.20	0.00	0.28	0.64	0.09	0.00	0.00	0.23		0.00	0.00	0.00
79.00	0.00	0.00	0.00	0.00	0.00	0.26	0.10	0.40	0.08	0.10		0.00	0.00	0.00
80.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.45	0.00	0.07		0.00	0.00	0.00
81.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.10		0.00	0.00	0.00
82.00	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.01	0.00		0.00	0.00	0.06
83.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10		0.00	0.00	0.07
84.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08		0.00	0.00	0.00
85.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.00		0.00	0.00	0.00
86.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.00		0.00	0.00	0.00
87.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
88.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
89.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
90.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
91.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
92.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
93.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
94.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
95.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
96.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
97.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00		0.00	0.00	0.00
98.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
99.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
######	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00

Part2

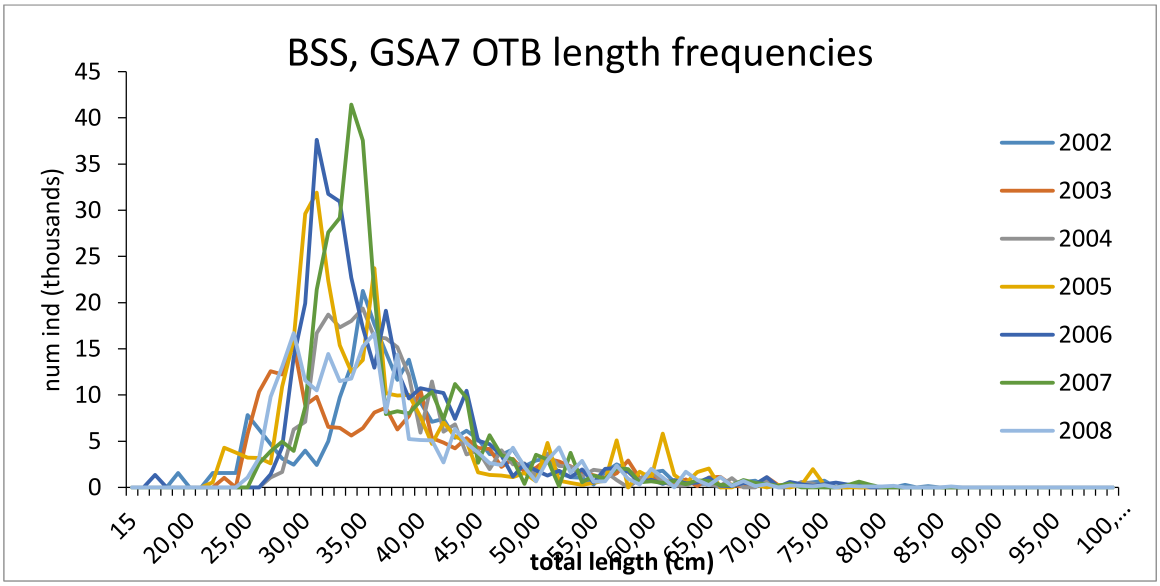


Figure 6.1.1.2.1. European seabass in GSA 7. Size distribution of catch for otter trawlers from 2002 to 2015

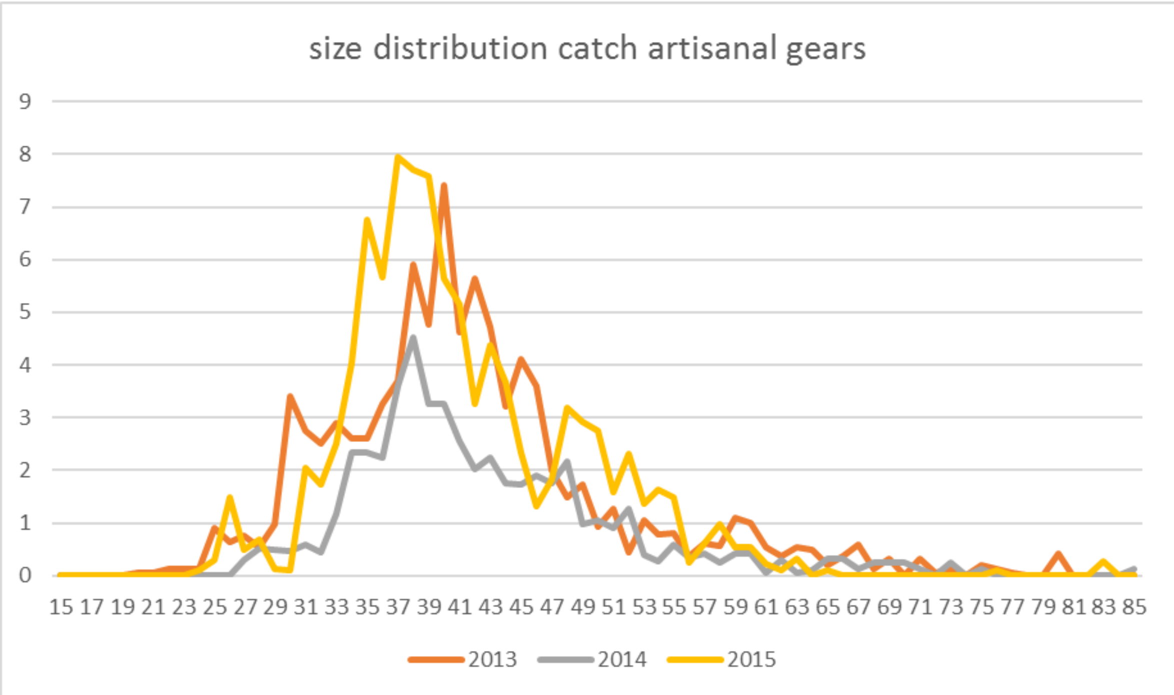
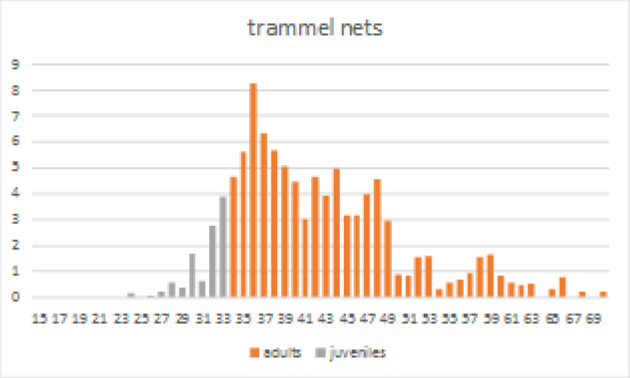
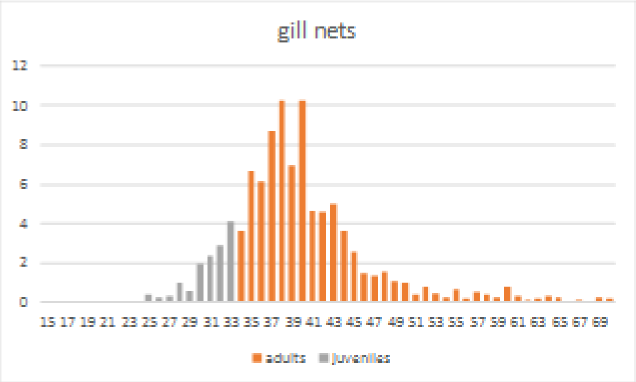


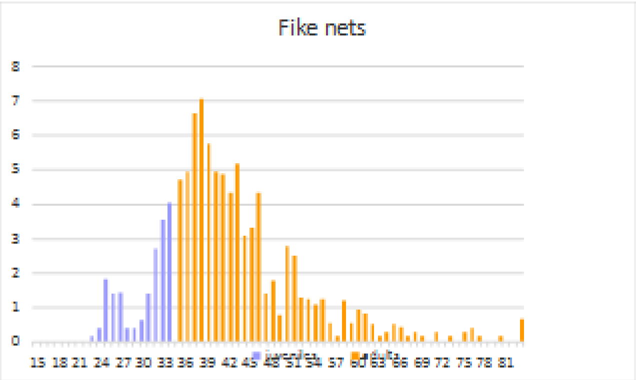
Figure 6.1.1.2.2. European seabass in GSA 7. Size distribution of catches of artisanal gears

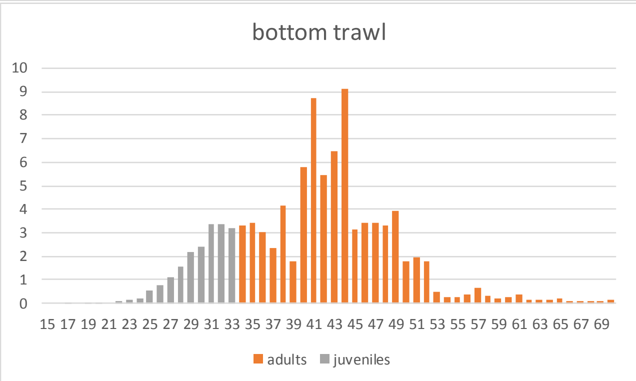
No discards data are available.

Individuals of age 1 and 2 (mostly immature individuals) represent a relatively important fraction of the catch, especially in the case of fykenets and bottom trawl nets


trammel nets
0 1 2 3 4 5 6 7 8 9
15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69
adults juveniles


gill nets
0 2 4 6 8 10 12
15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69
adults juveniles


Fike nets
0 1 2 3 4 5 6 7 8


bottom trawl
0 1 2 3 4 5 6 7 8 9 10
15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69
adults juveniles

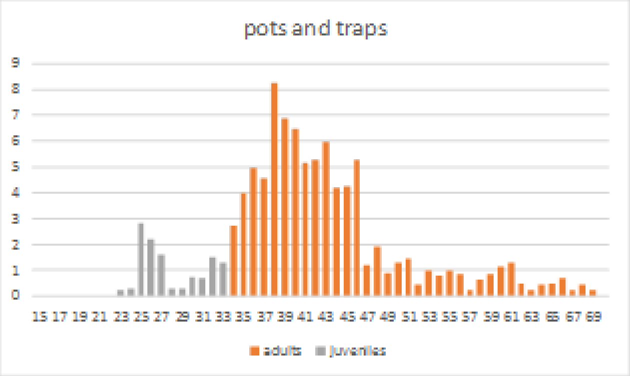


Figure 6.1.1.2.3. European seabass in GSA 7. Size structure of the catch of adults and juveniles of seabass by gear

6.1.1.3 Fishing effort data

There is no information on effort specifically on seabass for either Spanish or French fleets. Spain provided data on effort for the whole fleet. It is unknown whether the effort exerted by these fleets (or part of them) impacts the seabass population. French data is only partial, with effort by gear only for 2015, and the total by year is not constent between the year with detrails by gear (2015) and earlier years.

Table 6.1.1.3.1. European seabass in GSA 7. Effort in days fishing of Spanish and French fleets operating in GSA7

Sum of the days at sea											
Spain											
	Gear										
Year	-1	DRB	FPO	GNS	GTR	LLD	LLS	OTB	PS	SV	Total ESP
2004	194		165	192	293		1362	3714	755		6675
2005	121		130	162	285		1174	3626	515		6013
2006	121		196	167	208		1164	3550	247		5653
2007	123		201	194	179		1137	3553	293		5680
2008	160		271	228	157	21	1250	3694	184		5965
2009				11	4	119	402	3008	94		3638
2010			238	453	212		1394	3097	4		5398
2011			237	411	119		949	3486	167	138	5507
2012			350	188	70		872	2966	15	35	4496
2013		1	375	234	59		908	2791	52	2	4422
2014			324	240	65	5	1048	2966			4648
2015		1	413	185	143	5	939	3064	2		4752
Total general	719	2	2900	2665	1794	150	12599	39515	2328	175	62847

	days at sea by gear FRANCE

year	-1	DRB	FPO	FYK	GND	GNS	GTR	LHP	LLD	LLS	LTL	OTB	OTM	OTT	PS	SB	Total
2004																	6675
2005																	6013
2006																	5653
2007																	5680
2008																	5965
2009																	3638
2010																	5358
2011																	5567
2012																	4496
2013																	4422
2014																	4648
2015	20443	566	6682	10551	141	36188	43299	2052	2449	5202	47	9939	386	736	883	178	139743

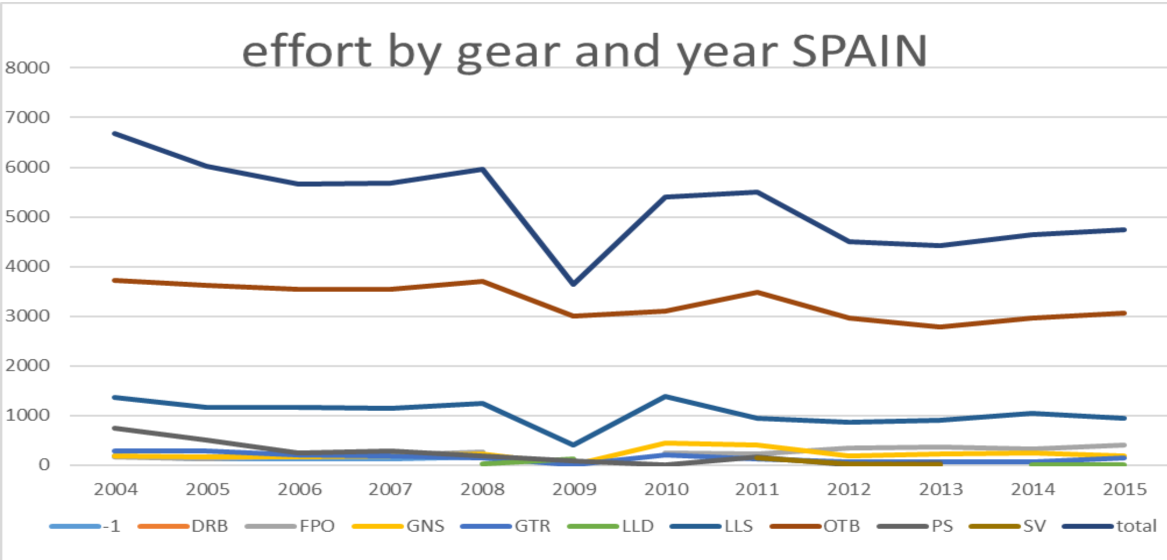


Figure 6.1.1.3.1. European seabass in GSA 7. Effort by gear and year of Spanish fleet

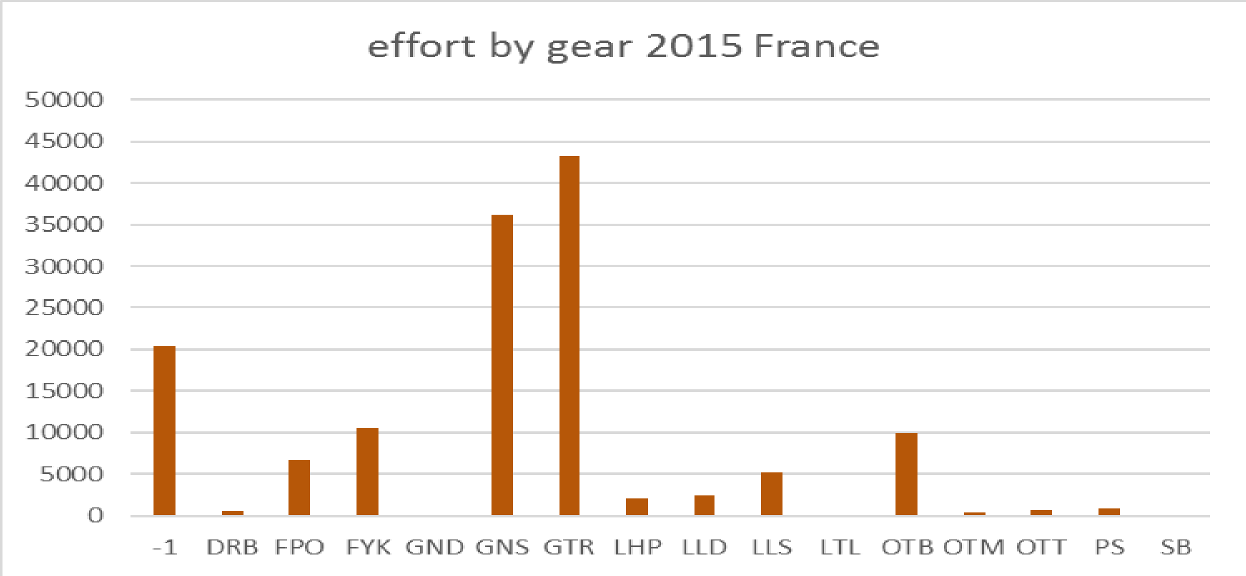


Figure 6.1.1.3.2. European seabass in GSA 7. Effort by gear in 2015 of French fleet

6.1.1.4 Survey Indices of abundance and biomass by year and size/age

MEDITS program of trawl surveys provides data of catch per tow of seabass for the period from 1994 to 2012. The catches are very low with a minimum number caught in 1994 and a maximum of 16 individuals during the 2009 survey. The extremely small numbers caught every year can be explained by the species behaviour, as is more concentrated near the shore, where MEDITS tows are not carried out. It is likely that the modest catches can be also linked to seasonal spatial shifts of the species, which moves from the coastal lagoons or river mouths to areas in open sea and vice-versa. The limited information from surveys does not allow us to derive any sound conclusions regarding changes in abundance over time.

Table 6.1.1.4.1. European seabass in GSA 7. Numbers caught by MEDITS surveys

BSS, GSA7 MEDITS data		
Year	Total number	Total weight (kg)
1994	1	0.7
1995	5	4
1996	11	12.5
1998	2	1.1
1999	2	1.2
2000	2	1.6
2001	4	5.9
2002	1	2.6
2003	3	5.5
2004	4	11.4
2005	11	6.6
2006	7	3.4

2007	13	6
2008	3	1.9
2009	16	10.8
2010	7	10.4
2012	2	2.2

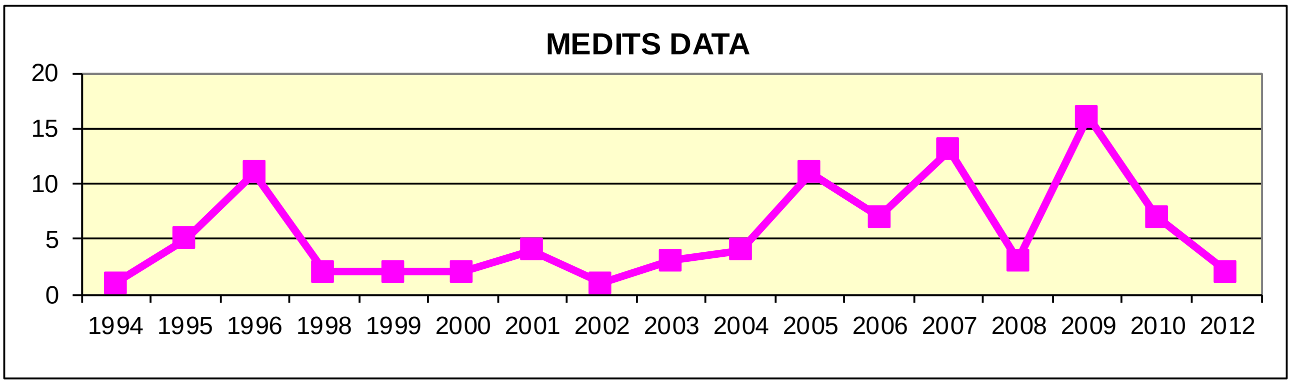


Figure 6.1.1.4.1. European seabass in GSA 7. Numbers of individuals by year from MEDITS survey

6.1.2 STOCK ASSESSMENT ON EUROPEAN SEABASS IN GSA 7

Method 1- VPA in pseudo-cohort by year

The VIT program (Lleonart & Salat, 1992) was conceived for the analysis of fisheries where the time series is limited and where the technical interaction among fishing gears is an important factor to account for. The main assumption underlying the model is the steady state, as the program works with pseudo-cohorts. In consequence, the software is not suitable for the analysis of series of historical data on catch by age/size. The program uses the catch data and ancillary parameters for rebuilding the population of the species and the mortality vectors affecting it using a VPA.

Data of only 3 years (2013-2015) were available and hence one run was done with catch data corresponding to each year. The analyses were done separately by otter trawls and for the artisanal gears pooled.

Size compositions of the catches were transformed in age using a slicing procedure based on the growth parameters). Natural mortality was obtained applying PRODBIOM and the Hoenig method (1983). In addition, Yield-per-Recruit (YPR) routine included in VIT was performed for the estimation of the reference point $F_{0.1}$ (assumed a proxy of F_{MSY}).

CHOSEN PARAMETERS

growth by length

ORIGIN	Linf	k	t_0
Gulf Lions	83.4	0.26	

L/W

ORIGIN	a	b
Gulf Lions	0.0157	2.884

M=0.15

Maturity at age

age	size	Fraction mature
1	19.12	0
2	33.86	1
3	45.22	1
4	53.99	1
5	60.74	1
6	65.95	1
7	69.97	1
8	73.07	1
9	75.46	1
10	77.30	1
11	78.72	1
12	79.81	1
13	80.66	1
14	81.31	1
15	81.81	1
16	82.20	1
17	82.50	1
18	82.73	1
19	82.90	1
20	83.04	1

The VIT assessments were carried out structured by age

AGE SLICING catch X age for artisanal (ART)=gear2 and trawlers (OTB)=gear 1

2013			2014			2015		
ART	OTB	Age	ART	OTB	Age	ART	OTB	Age
15.498	5.995	1	3.801	3.43	1	9.205	18.633	1
49.799	27.963	2	30.688	10.673	2	62.67	60.077	2
15.679	2.208	3	11.739	6.856	3	19.069	19.889	3
5.008	0.984	4	2.594	3.871	4	5.946	3.646	4
2.398	0.527	5	0.911	0.472	5	0.915	0.671	5
1.389	0.28	6	0.986	0.263	6	0.027	0.259	6
0.398	0.183	7	0.79	1.416	7+	0.113	0.549	7+
0.199	0.25	8						
0.703	0.19	9+						

	total catch	ART	OTB
2013	306.1	0.92	0.08
2014	230.9	0.91	0.09
2015	272.0	0.95	0.05

Terminal F values for oldest ages in each year were defined after several trials for assessing sensitivity and were chosen respectively as 0.3, 0.2 and 0.3 for 2013, 2014 and 2015. Plus groups were defined in order to reduce non-realistic estimates for the older age classes, as the number of individuals in each age were limited or in some cases were completely lacking. For 2013 a plus group 9+ was defined while plus-group for the other two years was fixed as 7+

Table 6.1.2.1.1. European seabass in GSA 7. Results from VIT VPA for 2013, the estimates of Z and F are highlighted in grey.

RESULTS OF VPA for OTB (gear 1) and ARTISANAL (gesr 2)

2013

Ft=0.3 Plusgrup=9

Catch in Numbers

Class		Total catch	Catch of gear 1	Catch of gear 2
	1	63520.75	4771.28	58749.47
	2	289361.6	15331.32	274030.3
	3	26464.84	4827	21637.84
	4	11184.73	1541.78	9642.95
	5	5902.72	738.26	5164.47
	6	3171.55	427.62	2743.93
	7	1915.88	122.53	1793.35
	8	2511.2	61.26	2449.94
+		2078.38	216.43	1861.95
Total		406111.7	28037.48	378074.2
Mean Age		2.539	2.764	2.522
Mean Length		39.766	41.821	39.613

Catch in Weight

Class		Total catch	Catch of gear 1	Catch of gear 2
	1	14463329	1086394	13376936
	2	1.82E+08	9629096	1.72E+08
	3	34215219	6240615	27974604
	4	22094069	3045604	19048466

	5	15547275	1944509	13602766
	6	10243005	1381073	8861931
	7	7172034	458685.8	6713348
	8	10455566	255081	10200485
+		10171040	1059143	9111897
Total		3.06E+08	25100200	2.81E+08
Percentage		---	8.2	91.8

VPA Results--Numbers

Class		Initial number	Mean number		
	1	522634.7	453673.4		
	2	391062.9	189732.1		
	3	73241.5	54120.89		
	4	38658.52	30127.53		
	5	22954.66	18292.06		
	6	14308.13	11674.31		
	7	9385.43	7744.97		
	8	6307.8	4526.86	adults	>2
+		3117.57	6927.93	323146.6	
Total		---	776820.1		
Stock Mean Age		---	2.302		
Stock Mean Length		---	35.636		

VPA Results--Weight

Class		Initial Weight	Mean Weight	
	1	43588458	1.03E+08	
	2	1.7E+08	1.19E+08	
	3	73174956	69970508	
	4	64372832	59513243	
	5	53707191	48179736	
	6	42443728	37703943	
	7	33017284	28992985	
	8	25143112	18847918	
+			13634584	33903466
Total		---	5.2E+08	
SSB		---	5.2E+08	

VPA Results--Mortalities

Class		Z	Total F	F of gear 1	F of gear 2
	1	0.29	**0.14**	0.011	0.129
	2	1.675	**1.525**	0.081	1.444
	3	0.639	**0.489**	0.089	0.4
	4	0.521	**0.371**	0.051	0.32
	5	0.473	**0.323**	0.04	0.282
	6	0.422	**0.272**	0.037	0.235
	7	0.397	**0.247**	0.016	0.232
	8	0.705	**0.555**	0.014	0.541

+	0.45	0.3	0.031	0.269
Mean Mort. rates				
Global Fs	---	**0.523**	0.036	0.487
---	Critical age	Critical length		
Current stock	2	34.668		
Virgin stock	7	71.647		
Total Biomass balance (D): 384036284.02				
---	Biomass	Percentage		
Recruitment	43588458	11.35		
Growth	3.4E+08	88.65		
Natural death	77936284	20.29		
Fishing	3.06E+08	79.71		
R/B(mean)	8.39			
D/B(mean)	73.91			
B(max)/B(mean)	32.63			
	B(max)/D			
	44.1544.15			

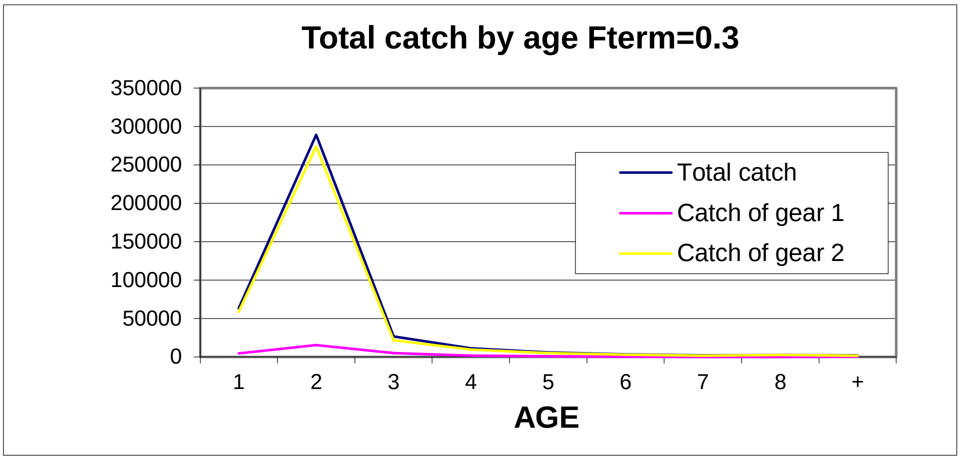


Figure 6.1.2.1.1. European seabass in GSA 7. Catch numbers at age in 2013

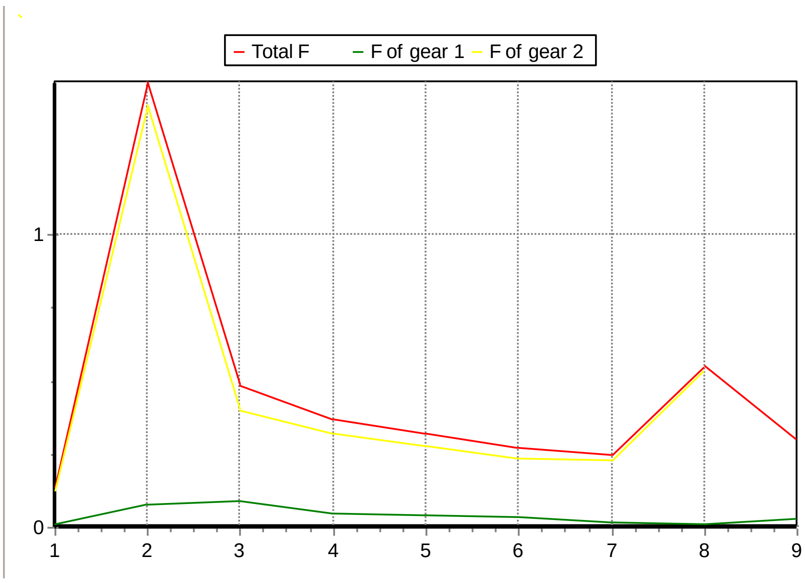


Figure 6.1.2.1.2. European seabass in GSA 7. F at age for gear 1 (OTB) and gear 2 (Artisanal) for 2013

Table 6.1.2.1.2. European seabass in GSA 7. Results from VIT VPA for 2014, the estimates of Z and F are highlighted in grey.

	RESULTS OF VPA			
		2014		
Ft=0.2		Plusgrup=7		
Catch in Numbers				
Class		Total catch	Catch of gear 1	Catch of gear 2
	1	22759.32	1450.75	21308.57
	2	78017.94	11712.86	66305.07
	3	47072.79	4480.49	42592.3
	4	25038.31	990.07	24048.25
	5	3279.96	347.71	2932.26
	6	2010.2	376.33	1633.86
+		9098.3	301.52	8796.78
Total		187276.8	19659.73	167617.1
Mean Age		3.303	2.948	3.344
Mean Length		46.71	44.544	46.964
Catch in Weight				
Class		Total catch	Catch of gear 1 1	Catch of gear 2
	1	5392388	343727.4	5048660
	2	54377841	8163766	46214075
	3	62765876	5974193	56791683
	4	50808672	2009080	48799592
	5	8966488	950530.3	8015957
	6	6728978	1259743	5469235
	+	41859757	1387261	40472497
Total		2.31E+08	20088300	2.11E+08
Percentage		---	8.7	91.3
VPA Results—Numbers				
Class		Initial number	Mean number	
	1	281611.4	250253.2	
	2	221314.1	164650.8	
	3	118598.6	85196.94	
	4	58746.23	41185.13	
	5	27530.14	23931.21	
	6	20660.5	18188.5	
+		15922.02	45491.5	

Total	---	628897.3
Stock Mean Age	---	3.096
Stock Mean Length	---	42.557

VPA Results--Weight

Class	Initial Weight	Mean Weight	
1	24287775	59292738	
2	99230546	1.15E+08	
3	1.23E+08	1.14E+08	
4	1.01E+08	83574397	
5	66609196	65421100	
6	63377575	60884612	
+		57922811	2.09E+08
Total	---	7.07E+08	
SSB	---	6.95E+08	

VPA Results--Mortalities

Class	Z	Total F	F of gear 1	F of gear 2
1	0.241	**0.091**	0.006	0.085
2	0.624	**0.474**	0.071	0.403
3	0.703	**0.553**	0.053	0.5
4	0.758	**0.608**	0.024	0.584
5	0.287	**0.137**	0.015	0.123
6	0.261	**0.111**	0.021	0.09
+	0.35	**0.2**	0.007	0.193
Mean Mort. rates				
Global Fs	---	**0.298**	0.031	0.267

---	Critical age	Critical length
Current stock	3	46.848
Virgin stock	6	68.323

Total Biomass balance (D): 336924752.85

---	Biomass	Percentage
Recruitment	24287775	7.21
Growth	3.13E+08	92.79
Natural death	1.06E+08	31.47
Fishing	2.31E+08	68.53
R/B(mean)	3.44	
D/B(mean)	47.67	
B(max)/B(mean)	17.34	
B(max)/D	36.37	

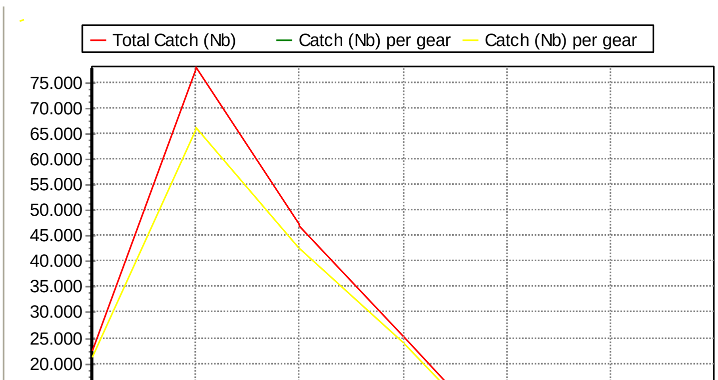


Figure 6.1.2.1.3. European seabass in GSA 7. Catch numbers at age in 2014

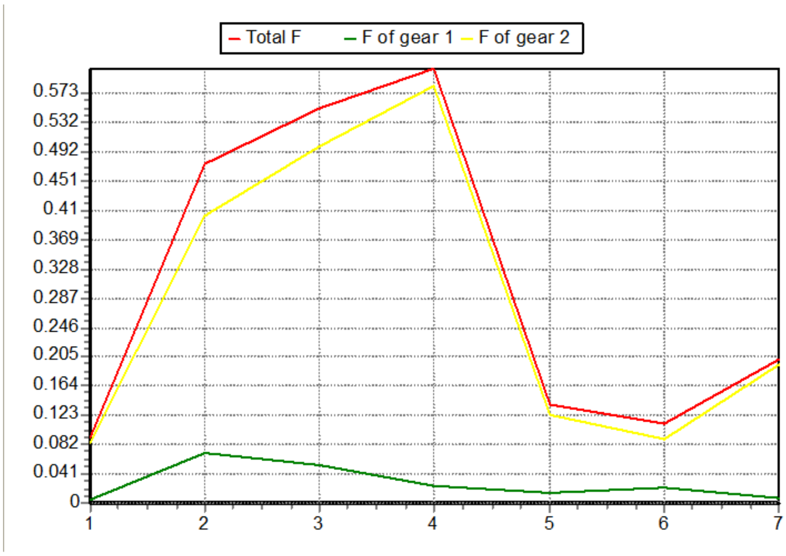


Figure 6.1.2.1.4. European seabass in GSA 7. F at age for gear 1 (OTB) and gear 2 (Artisanal) for 2014

Table 6.1.2.1.3. European seabass in GSA 7. Results from VIT VPA for 2015, the estimates of Z and F are highlighted in grey.

RESULTS OF VPA

2015

Ft=0.3 Plusgrup=7

Catch in Numbers

Class	Total catch	Catch of gear 1	Catch of gear 2
1	60920.66	2286.51	58634.15
2	204616.9	15567.15	189049.8
3	67323.24	4736.72	62586.52

4	12950.18	1476.98	11473.2	
5	2338.78	227.28	2111.5	
6	821.73	6.71	815.02	
+	1755.66	28.07	1727.59	
Total	350727.2	24329.42	326397.7	
Mean Age	2.566	2.664	2.559	
Mean Length	40.51	41.842	40.411	

Catch in Weight

Class	Total catch	Catch of gear 1	Catch of gear 2
1	13861163	520245.4	13340917
2	1.32E+08	10080444	1.22E+08
3	84109824	5917784	78192040
4	25158926	2869397	22289529
5	6147908	597459.2	5550449
6	2655031	21669.85	2633361
+	7568327	121000.7	7447326
Total	2.72E+08	20128000	2.52E+08
Percentage	---	7.4	92.6

VPA Results--Numbers

Class	Initial number	Mean number	
1	448959	386470.3	
2	330067.8	190255	
3	96912.67	50530.76	268408.9
4	22009.81	13166.64	
5	7084.64	5360.53	
6	3941.78	3243.78	
+	2633.49	5852.19	
Total	---	654879.2	
Stock Mean Age	---	2.076	
Stock Mean Length	---	34.063	

VPA Results--Weight

Class	Initial Weight	Mean Weight	
1	37538429	87932853	
2	1.43E+08	1.23E+08	
3	96886078	63130262	
4	36665002	25579464	
5	16580638	14091109	
6	11695250	10480788	
+		9265762	25227755
Total	---	3.5E+08	
SSB	---	3.32E+08	

VPA Results--Mortalities

Class	Z	Total F	F of gear 1	F of gear 2

1	0.308	**0.158**	0.006	0.152
2	1.225	**1.075**	0.082	0.994
3	1.482	**1.332**	0.094	1.239
4	1.134	**0.984**	0.112	0.871
5	0.586	**0.436**	0.042	0.394
6	0.403	**0.253**	0.002	0.251
+	0.45	**0.3**	0.005	0.295
Mean Mort. rates				
Global Fs	---	**0.536**	0.037	0.498
---	Critical age	Critical length		
Current stock	2	34.682		
Virgin stock	6	67.538		
Total Biomass balance (D): 324446155.27				
---	Biomass	Percentage		
Recruitment	37538429	11.57		
Growth	2.87E+08	88.43		
Natural death	52446155	16.16		
Fishing	2.72E+08	83.84		
R/B(mean)	10.74			
D/B(mean)	92.79			
B(max)/B(mean)	40.98			
B(max)/D	44.16			

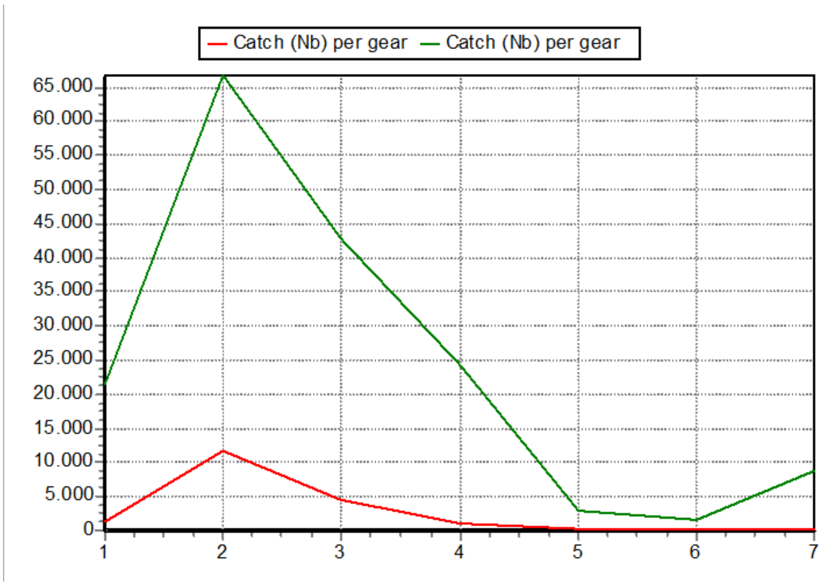


Figure 6.1.2.1.5. European seabass in GSA 7. Catch numbers at age in 2015

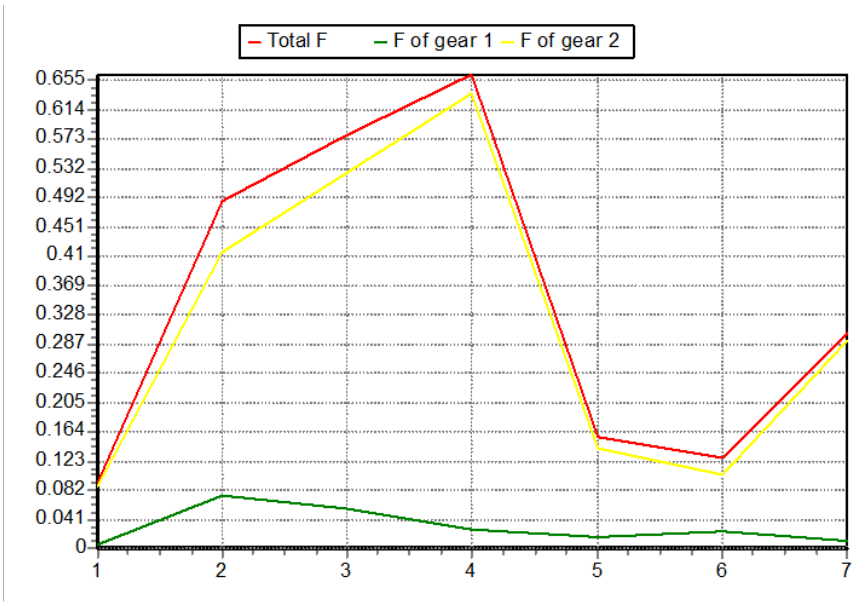


Figure 6.1.2.1.6. European seabass in GSA 7. F at age for gear 1 (OTB) and gear 2 (Artisanal) for 2015

It is not possible to assess trends as the time series is too short and imprecise.

Recruitment numbers at sea derived from VIT software were estimated only for 2013-2015 period and do not allow any assessment of changes in such short long time interval. They regard age1 individuals.

Table 6.1.2.1.4. European seabass in GSA 7. Recruitment (Nx10-3) for the 3 analysed years.

Recruitment (age1)		
2013	2013	2013
453673.4	250253.2	386470.3

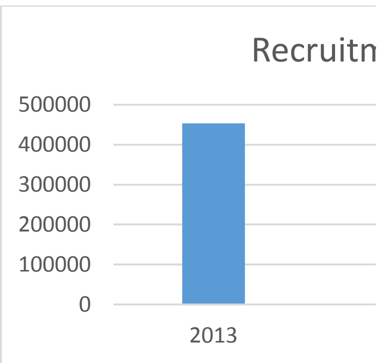


Figure 6.1.2.1.7. European seabass in GSA 7. Recruitment ($Nx10^{-3}$) for the 3 analysed years

Table 6.1.2.1.5. European seabass in GSA 7. Estimates of Spawning Stock Biomass

Year	SSB
2013	396.0
2014	496.2
2015	245.7

Table 6.1.1.4.2. European seabass in GSA 7. Recruitment and SSB estimates by age derived from VIT

SSB			
2013	2014	2015	
323146.6	378644.1	268408.9	N(thousands)
396.0	496.2	245.7	Wt (tons)

Method 2. Length-based analysis

Length-based methods were used for deriving some indicators explored in WKLIFE IV. (ICES, 2015). They allow classifying the stocks according to conservation/sustainability, yield optimization and MSY considerations. Analysis required data on the stock catch/landings–length composition and life-history parameters as Linf.

The length-based indicators analysis was performed using the commercial landings in 2013 to 2015 (discards considered negligible) and the following life-history parameters: Linf=83.4,.

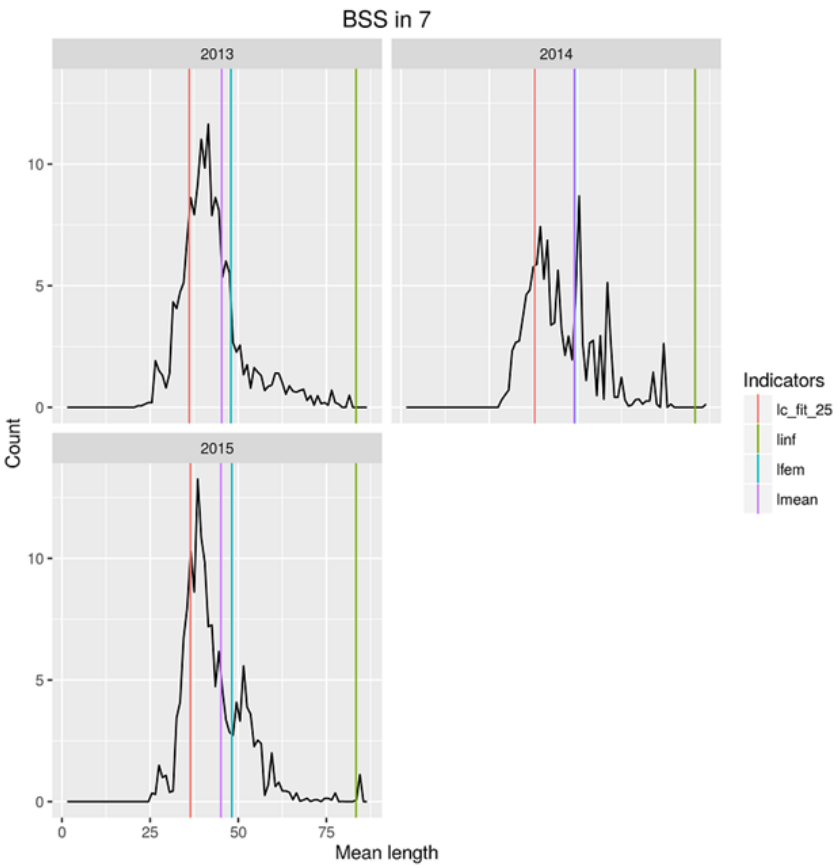


Figure 6.1.2.1.8. European seabass in GSA 7. Length-based indicators and reference points for seabass using the catch length composition for 2013, 2014, 2015

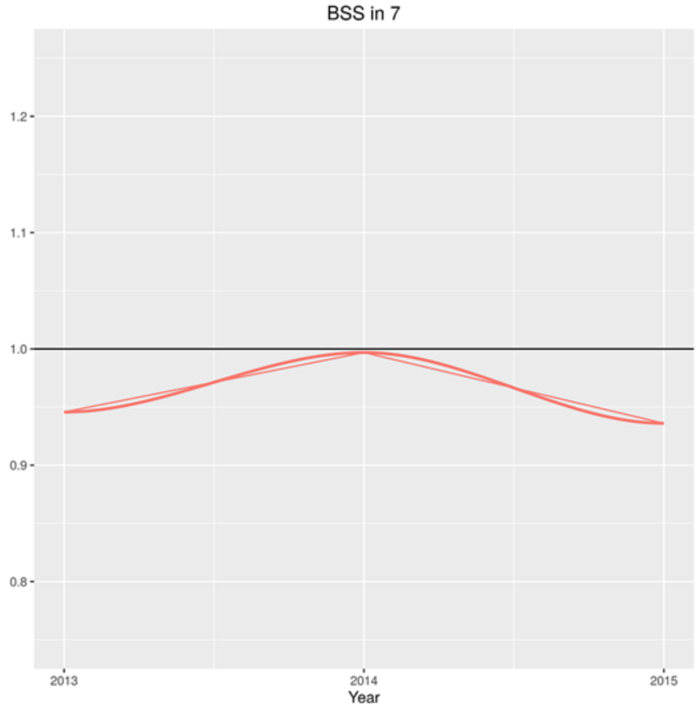


Figure 6.1.2.1.9. European seabass in GSA 7. Length-based indicator for seabass using the catch length composition for 2013, 2014, 2015

The overall perception from length-based indicators is that the stock is over fished at levels above MSY level. Such perception supports the result obtained with VIT VPA for the same years.

6.1.3 REFERENCE POINTS

Fixing limit reference points based on a maximum fishing mortality rate or minimum biomass from which a stock could be rebuilt to MSY is difficult due to data shortage and limited knowledge on the species life history and fishery. As uncertainty about stock status or productive capacity is too high, target catch levels or definitions of limits in F or B should be more cautious In this case, it was estimated using Y/R analysis the F0.1 reference point considered a proxy of FMSY. The reference value F0.1, the fishing mortality rate corresponding to 10% of the slope of the yield-per-recruit curve at the origin proposed by Gulland and Boerema, (1973) is frequently used in the Mediterranean as FMSY cannot in the major part of the cases be estimated as stock/recruitment relationships are unknown for most of the stocks in the area and Production models are seldom used. Because the yield-per-recruit analyses only reflect schedules of mortality and weight at age in the catch, $F_{0.1}$ is a reference point in the context of growth overfishing and is not informative regarding recruitment overfishing. $F_{0.1}$ was developed and promoted as a more prudent alternative (Gulland and Boerema, 1973). $F_{0.1}$ is commonly interpreted as a conservative or precautionary estimate of FMSY, but this is not always the case especially when age of first capture and maturity time schedules do not coincide (Mace, 1994; Mace and Sissenwine, 1993, Gabriel and Mace, 1999).

YPR reference points are not always sustainable. Studies suggest that the Y/R reference points Fmax and F0.1 for 3 cod stocks appear sustainable under high and average productivity conditions. Under low productivity conditions, while F_{MAX} is not sustainable $F_{0.1}$ is near the breakpoint of the S/R curve. Morgan et al, (2014). STCECF has adopted F0.1 as a precautionary proxy for F_{MSY}.

$F_{0.1}$ rates were estimated for the years 2013, 2014 and 2015 as factors related to the current F.

Year	Ffactor	Approx Abs F0.1	Estimated F/F0.1	Approx Absolute mean F
2013	0.26	0.135	3.8	0.523
2014	0.44	0.132	2.3	0,298
2015	0.24	0.139	4.2	0.536
Average	0.33	0.136	3.4	0.453

F0.1 is estimated with little variation, (0.132 to 0.139, average 0.136). In all the cases, the current levels of F are much higher than the rates correspondent to the reference value F0.1 for each year, and on average F is 3.4 times F0.1.

The results of Y/R for each year are shown in detail below with the factor of F0.1/Current F highlighted in grey.

Table 6.1.3.1. European seabass in GSA 7. Results Y/R for year 2013

Y/R 2013

F(0)	0	0	19040.92	19040.92	0	0
F(0.1)	0.26	720.508	6750.711	6750.711	68.548	651.96
Max Gear1	0.36	750.632	4981.669	4981.669	70.712	679.92
Max Gear2	0.39	752.233	4524.928	4524.928	70.596	681.637
Max(:)	0.39	752.233	4524.928	4524.928	70.596	681.637
phi=1	1.01	585.686	994.146	994.146	48.026	537.66
phi=2	2	429.29	338.988	338.988	27.582	401.708

Slope at origin	Virgin biomass	Method	Num_points	Resolution	Max factor of effort
6877.2208	9.95E+09	Calc. Mean wt.	40	0.05	2

Fvalue	Factor	Y/R	B/R	SSB	Y/R Gear 1	Y/R Gear 2	
0	0	0	19040.92	19040.92	0	0	
0.02615	0.05	281.969	15255.75	15255.75	27.294	254.674	
0.0523	0.1	468.306	12369.05	12369.05	45.163	423.142	
0.07845	0.15	589.902	10134.47	10134.47	56.67	533.232	
0.1046	0.2	667.188	8382.355	8382.355	63.829	603.359	
0.13075	**0.25**	**713.935**	**6993.064**	**6993.064**	**67.989**	**645.947**	F0.1
0.1569	0.3	739.573	5880.512	5880.512	70.071	669.501	
0.18305	0.35	750.632	4981.669	4981.669	70.712	679.92	
0.2092	0.4	751.683	4249.679	4249.679	70.357	681.327	
0.23535	0.45	745.946	3649.246	3649.246	69.32	676.626	
0.2615	0.5	735.696	3153.458	3153.458	67.825	667.871	
0.28765	0.55	722.551	2741.579	2741.579	66.033	656.518	
0.3138	0.6	707.656	2397.474	2397.474	64.058	643.598	
0.33995	0.65	691.821	2108.48	2108.48	61.984	629.838	
0.3661	0.7	675.616	1864.579	1864.579	59.869	615.747	
0.39225	0.75	659.437	1657.783	1657.783	57.758	601.679	
0.4184	0.8	643.553	1481.684	1481.684	55.679	587.874	
0.44455	0.85	628.144	1331.106	1331.106	53.655	574.489	
0.4707	0.9	613.324	1201.844	1201.844	51.699	561.625	
0.49685	0.95	599.16	1090.464	1090.464	49.821	549.34	
0.523	**1**	**585.686**	**994.146**	**994.146**	**48.026**	**537.66**	
0.54915	1.05	572.912	910.564	910.564	46.318	526.593	
0.5753	1.1	560.829	837.791	837.791	44.698	516.131	

0.60145	1.15	549.421	774.223	774.223	43.165	506.257
0.6276	1.2	538.662	718.519	718.519	41.717	496.945
0.65375	1.25	528.521	669.556	669.556	40.352	488.169
0.6799	1.3	518.966	626.386	626.386	39.068	479.898
0.70605	1.35	509.963	588.213	588.213	37.861	472.102
0.7322	1.4	501.477	554.357	554.357	36.727	464.75
0.75835	1.45	493.475	524.245	524.245	35.663	457.812
0.7845	1.5	485.925	497.386	497.386	34.665	451.26
0.81065	1.55	478.795	473.359	473.359	33.73	445.065
0.8368	1.6	472.057	451.808	451.808	32.854	439.204
0.86295	1.65	465.683	432.421	432.421	32.033	433.65
0.8891	1.7	459.647	414.935	414.935	31.265	428.382
0.91525	1.75	453.925	399.119	399.119	30.546	423.379
0.9414	1.8	448.494	384.774	384.774	29.873	418.621
0.96755	1.85	443.334	371.729	371.729	29.242	414.091
0.9937	1.9	438.424	359.834	359.834	28.652	409.772
1.01985	1.95	433.749	348.958	348.958	28.099	405.649
1.046	2	429.29	338.988	338.988	27.582	401.708

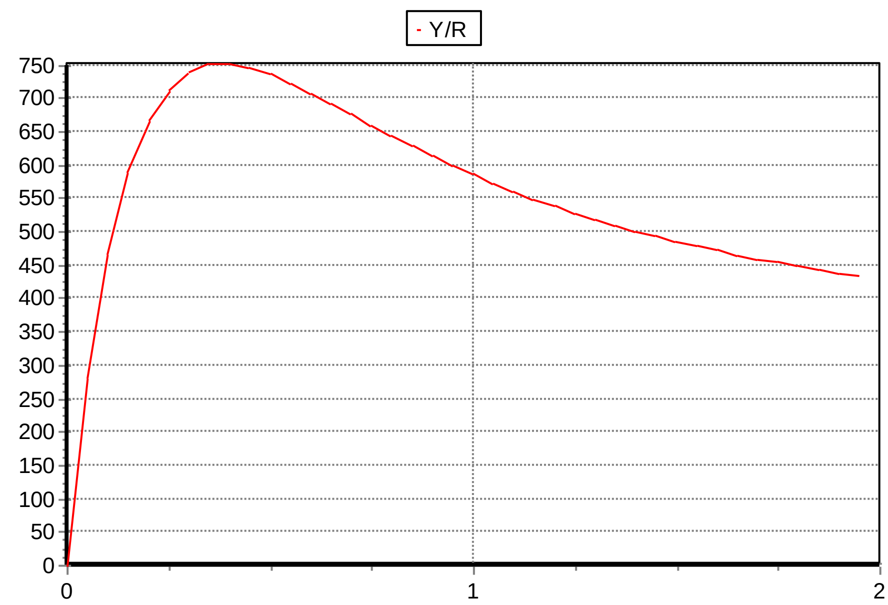


Figure 6.1.3.1. European seabass in GSA 7. Yield per recruit curve for 2013 (dashed line current situation expressed in relative F value)

Table 6.1.3.2. European seabass in GSA 7. Results Y/R for year 2014

Y/R 2014

	Factor	Y/R	B/R	SSB	Y/R Gear 1	Y/R Gear 2
F(0)	0	0	19690.28	19645.77	0	0
F(0.1)	0.44	817.278	6743.018	6699.583	57.761	759.516
Max Gear2	0.65	856.813	4547.836	4504.88	65.83	790.984
Max(:)	0.68	857.209	4304.765	4261.881	66.627	790.582

phi=1	1.01	819.924	2509.954	2467.844	71.333	748.591
Max Gear1	1.28	768.842	1749.132	1707.644	72.082	696.76
phi=2	2	644.068	877.997	838.135	69.665	574.403

Slope at origin	Virgin biomass	Method	Num_points	Resolution	Max factor of effort
4681.418	5.55E+09	Calc. Mean wt.	40	0.05	2

Fvalue	Factor	Y/R	B/R	SSB	Y/R Gear 1	Y/R Gear 2	
0.00	0	0	19690.28	19645.77	0	0	
0.01	0.05	206.865	17126.7	17082.315	11.992	194.873	
0.03	0.1	367.716	14976.41	14932.147	21.927	345.789	
0.04	0.15	492.767	13160.27	13116.129	30.199	462.568	
0.06	0.2	589.769	11616.85	11572.831	37.115	552.654	
0.07	0.25	664.664	10297.88	10253.982	42.917	621.747	
0.09	0.3	722.049	9165.015	9121.241	47.797	674.252	
0.10	0.35	765.512	8187.505	8143.853	51.909	713.603	
0.12	0.4	797.871	7340.469	7296.938	55.379	742.493	
0.13	**0.45**	**821.355**	**6603.617**	**6560.206**	**58.308**	**763.047**	F0.1
0.15	0.5	837.735	5960.284	5916.993	60.782	776.953	
0.16	0.55	848.426	5396.696	5353.525	62.869	785.557	
0.18	0.6	854.563	4901.397		64.627	789.936	
0.19	0.65	857.059	4464.809	4421.877	66.105	790.954	
0.21	0.7	856.653	4078.883	4036.07	67.343	789.31	
0.22	0.75	853.941	3736.823	3694.127	68.376	785.565	
0.24	0.8	849.409	3432.865	3390.287	69.232	780.176	
0.25	0.85	843.449	3162.103	3119.643	69.937	773.512	
0.27	0.9	836.383	2920.344	2878.001	70.51	765.873	
0.28	0.95	828.47	2703.992	2661.766	70.971	757.5	
0.30	**1**	**819.924**	**2509.954**	**2467.844**	**71.333**	**748.591**	Fcurr
0.31	1.05	810.917	2335.559	2293.565	71.611	739.305	
0.33	1.1	801.589	2178.496	2136.618	71.816	729.773	
0.34	1.15	792.054	2036.758	1994.995	71.957	720.097	
0.36	1.2	782.405	1908.6	1866.952	72.042	710.363	
0.37	1.25	772.716	1792.5	1750.966	72.08	700.636	
0.39	1.3	763.046	1687.125	1645.705	72.075	690.971	
0.40	1.35	753.443	1591.308	1550.002	72.034	681.41	
0.42	1.4	743.946	1504.025	1462.832	71.961	671.985	
0.43	1.45	734.583	1424.373	1383.294	71.86	662.723	
0.45	1.5	725.378	1351.558	1310.591	71.735	653.643	
0.46	1.55	716.347	1284.878	1244.023	71.589	644.758	
0.48	1.6	707.503	1223.711	1182.968	71.424	636.08	
0.49	1.65	698.856	1167.506	1126.874	71.243	627.613	
0.51	1.7	690.412	1115.774	1075.254	71.048	619.364	
0.52	1.75	682.173	1068.08	1027.671	70.84	611.332	
0.54	1.8	674.141	1024.038	983.739	70.622	603.519	
0.55	1.85	666.317	983.301	943.111	70.394	595.923	
0.57	1.9	658.698	945.561	905.481	70.158	588.54	
0.58	1.95	651.283	910.542	870.571	69.915	581.368	
0.60	2	644.068	877.997	838.135	69.665	574.403	

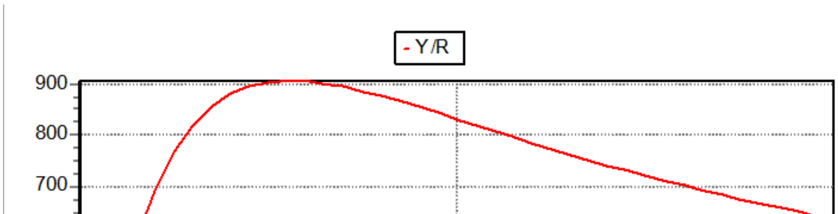


Figure 6.1.3.2. European seabass in GSA 7. Yield per recruit curve for 2014 (dashed line current situation expressed in relative F value)

Table 6.1.3.3. European seabass in GSA 7. Results Y/R for year 2015

Y/R 2015

___	Factor	Y/R	B/R	SSB	Y/R Gear 1	Y/R Gear 2
F(0)	0	0	19043.685	19000.58	0	0
F(0.1)	0.24	759.614	6017.146	5975.024	47.02	712.594
Max Gear2	0.35	790.71	4032.676	3990.957	52.059	738.651
Max(:)	0.36	790.872	3883.852	3842.173	52.34	738.531
Max Gear1	0.47	774.068	2642.12	2600.879	53.684	720.383
phi=1	1.01	605.846	778.782	739.61	44.833	561.013
phi=2	2	449.119	356.316	320.655	31.826	417.293

Slope at origin	Virgin biomass	Method	Num_points	Resolution	Max factor of effort
7977.986	8.55E+09	Calc. Mean wt.	40	0.05	2

Fvalue	Factor	Y/R	B/R	SSB	Y/R Gear 1	Y/R Gear 2	
0.00	0	0	19043.685	19000.58	0	0	
0.03	0.05	320.692	14618.563	14575.66	16.641	304.051	
0.05	0.1	523.301	11375.888	11333.19	28.689	494.612	
0.08	0.15	648.997	8965.291	8922.803	37.351	611.646	
0.11	0.2	724.141	7150.714	7108.43	43.492	680.649	
0.13	**0.25**	**765.906**	**5769.561**	**5727.48**	**47.744**	**718.161**	F0.1
0.16	0.3	785.629	4707.727	4665.847	50.576	735.052	
0.19	0.35	790.872	3883.852	3842.173	52.34	738.531	
0.21	0.4	786.716	3239.116	3197.637	53.304	733.413	
0.24	0.45	776.59	2730.477	2689.196	53.669	722.921	
0.27	0.5	762.812	2326.096	2285.012	53.591	709.221	
0.29	0.55	746.948	2002.199	1961.312	53.19	693.758	
0.32	0.6	730.05	1740.876	1700.184	52.557	677.493	
0.35	0.65	712.818	1528.53	1488.032	51.761	661.057	

0.38	0.7	695.711	1354.762	1314.457	50.857	644.854	
0.40	0.75	679.021	1211.567	1171.453	49.884	629.137	
0.43	0.8	662.927	1092.742	1052.819	48.873	614.054	
0.46	0.85	647.53	993.455	953.721	47.848	599.682	
0.48	0.9	632.879	909.917	870.372	46.825	586.054	
0.51	0.95	618.988	839.147	799.789	45.817	573.171	
0.54	**1**	**605.846**	**778.782**	**739.61**	**44.833**	**561.013**	Fcurr
0.56	1.05	593.429	726.942	687.955	43.877	549.552	
1.54	1.1	581.705	682.125	643.323	42.956	538.749	
0.62	1.15	570.635	643.125	604.505	42.07	528.566	
2.54	1.2	560.18	608.968	570.53	41.22	518.96	
0.67	1.25	550.3	578.864	540.608	40.408	509.892	
3.54	1.3	540.955	552.172	514.096	39.632	501.322	
0.72	1.35	532.107	528.366	490.469	38.892	493.214	
4.54	1.4	523.721	507.016	469.296	38.187	485.534	
0.78	1.45	515.763	487.764	450.221	37.514	478.249	
5.54	1.5	508.202	470.316	432.95	36.872	471.33	
0.83	1.55	501.01	454.427	417.236	36.26	464.75	
6.54	1.6	494.16	439.892	402.875	35.676	458.484	
0.88	1.65	487.627	426.539	389.694	35.119	452.508	
7.54	1.7	481.389	414.221	377.549	34.586	446.804	
0.94	1.75	475.426	402.817	366.316	34.076	441.35	
8.54	1.8	469.719	392.222	355.891	33.588	436.13	
0.99	1.85	464.249	382.346	346.184	33.12	431.129	
9.54	1.9	459.002	373.112	337.118	32.672	426.331	
1.05	1.95	453.963	364.454	328.627	32.241	421.723	
10.54	2	449.119	356.316	320.655	31.826	417.293	

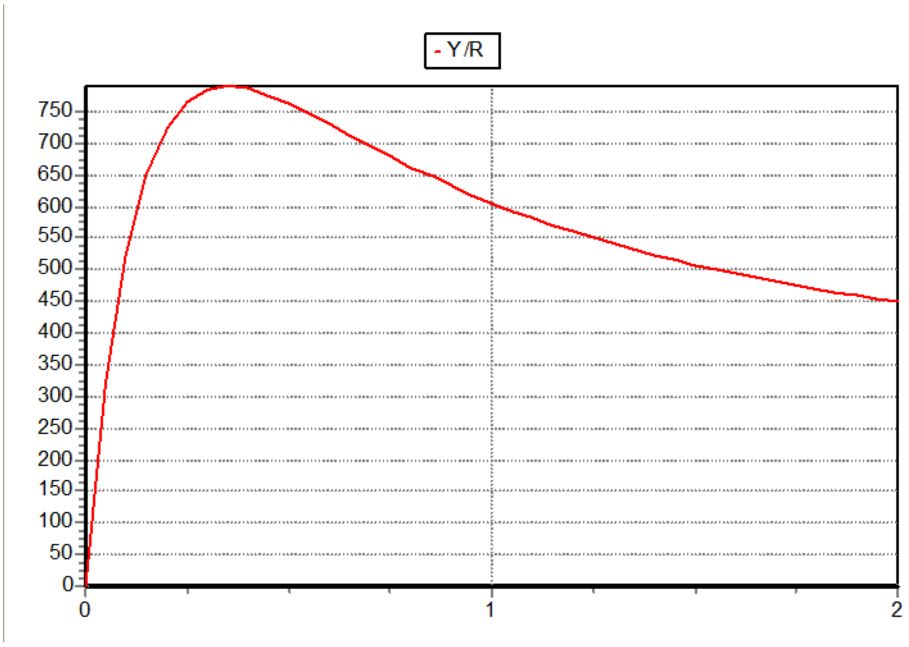


Figure 6.1.3.3. European seabass in GSA 7. Yield per recruit curve for 2015 (dashed line current situation expressed in relative F value)

6.1.4 SHORT TERM FORECASTS

With the available information is not possible to compute reliable medium term forecasts

6.1.5 QUALITY AND PROPOSALS FOR FUTURE ASSESSMENTS

Data for this species is very limited. Catch per unit of effort estimates are unfeasible as effort information is incomplete. In the case of Otter trawls, more complete for Spain than for France, but in both cases regard information at a level of aggregation that do not allow to separate the fraction of vessels that, considering the depth range where they operate, may include the species in the catch. Without such information is not possible to derive cpue values that may help to find any change in abundance along time. Specific effort information for the other gears is completely lacking. Almost complete landings data by metier is only available for France catches (that represent more than 95% of the total) but only for the years 2013-2015. Size/age structure of the commercial catch for all the métiers that capture the species is only available for the same short period and this preclude the use of data for a robust analytical approach aimed at the assessment of the stock status and in particular of the evolution of adult biomass along time. Time series of effort is incomplete, show evident inconsistencies and regards the overall effort by gear, making such data useless.

In conclusion, with the available information was not possible to advice regarding the stock status and on the evolution of biomass stock levels. However, the analyses all support the conclusion that the stock is being exploited above F=FMSY (F0.1 used as a proxy for FMSY). It is likely that many years will be needed before a sound assessment of the stock status over time could be carried out.

6.2 EUROPEAN SEABASS IN GSA 1, 5, 6 AND 7

6.2.1 DATA GATHERING OF EUROPEAN SEABASS IN GSAs 1, 5, 6 AND 7

All available data is documented under section 6.1.1 for European seabass in area 7. The magnitude of the catches reported from other areas are considered negligible.

6.2.2 STOCK ASSESSMENT ON EUROPEAN SEABASS IN GSA 1, 5, 6 AND 7

No combined evaluation was possible, for best information on the stock status see European seabass in GSA 7 (Section 6.1.2).

6.3 ANGLERFISH IN GSA 6

6.3.1 DATA GATHERING OF ANGLERFISH IN GSA 6

GSA 6 and GSA 7 are neighbor geographic sub areas (Figure 6.5.1.2.1). There is a fraction of the landings in ports of Spain, at the north of the GSA 6, that come from catches made in the GSA 7 (Table 6.3.1). The time series of the bottom trawl fleet landings of *Lophius piscatorius*, which account for a mean 95% of the total landings, were the only ones presenting the minimum quality in the length distribution and landing data allowing the analyses. See for example the high variability in the three years available of landings data of gill nets; trammel nets, and long lines for both Spanish and

French fleets. There is also more variability in the Spanish otter bottom trawl landings from GSA 7 than for those from the GSA 6, particularly for the three years for which we have the most complete set of data from the two countries and GSAs. In this sense, in 2013 the landings in GSA 7 for the Spanish fleet showed the minimum of the whole series coinciding with the maximum from that GSA for the French fleet. It points out that some of the catches produced in GSA 7 by the Spanish fleet may have been considered to come from the GSA 6. Moreover, the length distributions for the GSA 7 do not have enough quality (probably due to they come from few individuals some years) if considered separately by country (Figure 6.4.1), and depend on the year. It must be also taken account that the studies available point out that the species has a home range very large, with individuals having displacements of hundreds of km in just 2-3 years, i.e. embracing larger areas than those defined by the GSAs under assessment.

Table 6.3.1. Anglerfish in GSA 6. Available landings by year and country for GSA 6 and 7.

Country	SPAIN						FRANCE					
GSA	GSA 6				GSA 7		GSA 7					
Year/Gear	GNS	GTR	LLS	OTB	LLS	OTB	GNS	GTR	LLS	OTB	OTM	OTT
2002				188.6	0.7	37.3						
2003				233.8	0.9	34.0						
2004				228.2	0.9	52.3						
2005				289.7	1.0	70.4						
2006				346.8	0.7	62.8						
2007				275.0	0.7	52.8						
2008				212.8	0.6	46.6						
2009				302.9	1.1	38.6						
2010				402.4	1.0	36.4						
2011				901.7	1.4	37.2						
2012				370.1	0.6	28.3						
2013	0.7	4.5	1.4	298.7	0.8	24.2	8.7	32.6		82.4		
2014	2.0	10.9	5.0	233.1	3.7	65.7	3.9	32.9		64.6	0.5	12.5
2015	0.7	3.3	0.9	174.1	1.6	65.1	0.6	4.0	0.002	35.5	0.2	3.5

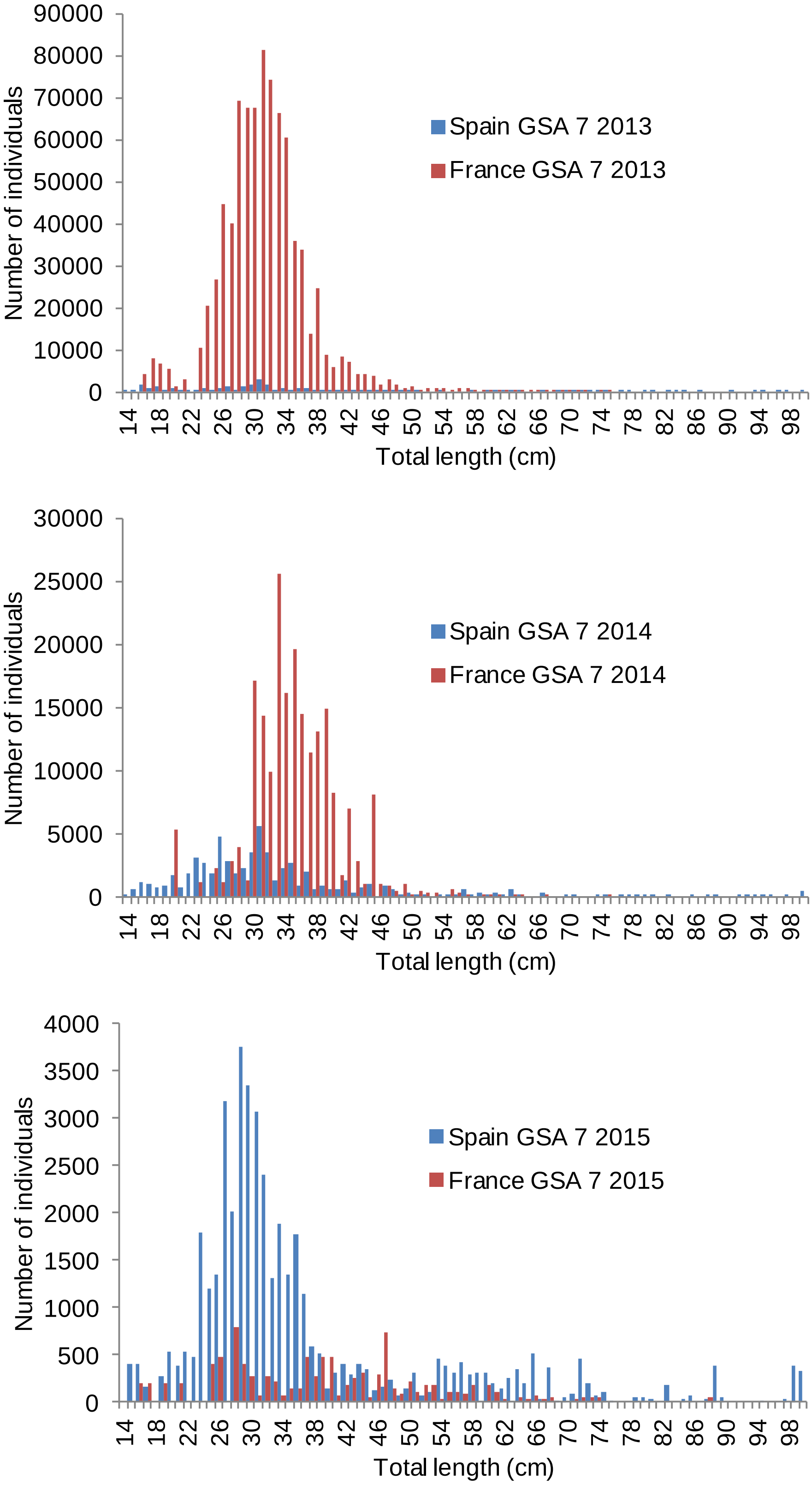


Figure 6.3.1. Anglerfish in GSA 6. Length size distribution for the three years with data available for GSA 7 from Spain and France.

6.3.2 STOCK ASSESSMENT ON ANGLERFISH IN GSA 6

No Separate evaluation possible for GSA 6, please see Section 6.5 anglerfish in GSAs 1,5,6 AND 7

6.4 ANGLERFISH IN GSA 7

6.4.1 DATA GATHERING OF ANGLERFISH IN GSA 7

See section 6.3.1

6.4.2 STOCK ASSESSMENT ON ANGLERFISH IN GSA 7

No Separate evaluation possible for GSA 7, please see Section 6.5 anglerfish in GSAs 1,5,6 AND 7

6.5 ANGLERFISH IN GSAs 1, 5, 6 AND 7

6.5.1 DATA GATHERING OF ANGLERFISH IN GSAs 1, 5, 6 AND 7

6.5.1.1 Stock Identity and Biology

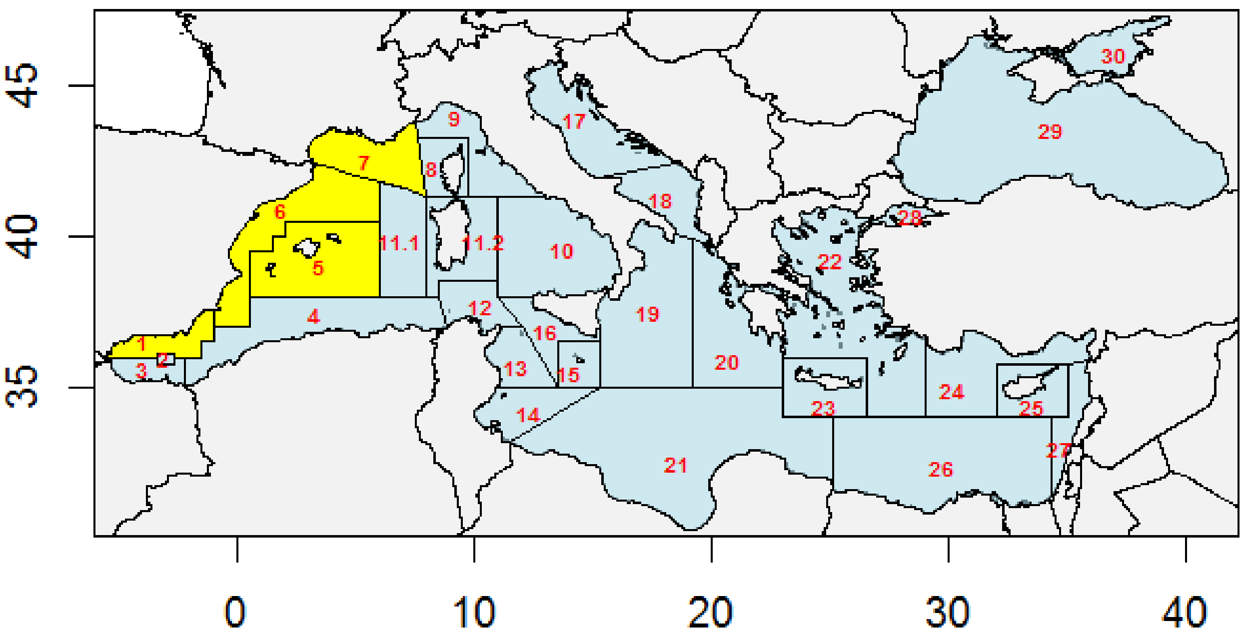


Figure 6.5.1.2.1 Geographical location of the GSAs 1,5,6 and 7.

The genus *Lophius* LINNEO, 1758 is represented by two species in the Eastern Atlantic and Mediterranean, *L. piscatorius* and *L. budegassa*. *L. piscatorius* is mainly distributed from the south western Barents Sea and Iceland to the Strait of Gibraltar, including the Mediterranean Sea (Whitehead et al 1986). While *L. piscatorius* dominates north of the 55ºN, *L. budegassa* is more prevalent in southern areas and mainly distributes from the British Isles to Senegal, including the Mediterranean as well. The two species are distinguished using, among other other characteristics, the different shape of the illicium and more easily by the different colour of the peritoneum which is white in *L. piscatorius* and black in *L. budegassa.* Both species have a wide, overlapped bathymetric range, from near the shore (<50 m), down to the slope (Ungaro et al. 2002; Velasco et al. 2008). *L. piscatorius* seems to have even a wider distribution even appearing close to the surface in winter (5-10 m depth, Coll et al. 2004) deeper than 1000 m depth (Whitehead et al. 1986).The morphological similarity between the two species along with their bathymetric overlap, makes that the two species are commonly marketed together as one (Velasco et al. 2008).

The two species are widely distributed in the Mediterranean, where they have been considered as part of the target species in the multispecies bottom trawl fishery developed in this Sea (Ungaro et al. 2002). These last authors studied the distribution of both species in the Mediterranean bottom trawl fishery using the data collected from the MEDITS surveys, which covers the continental shelf and slope bottoms. They analyzed more than six thousand hauls throughout the whole European Mediterranean, finding that the overall occurrence in those samples was lower for L. Piscatorius, 15%, than that for L. budegassa, occurring in 38% of samples.

The knowledge on the biology and distribution of these species in the Mediterranean is very limited (our search only found that work of Ungaro et al. 2002), with most of the information on general biology coming from the Atlantic area.

In Atlantic waters, in the case of *L. piscatorius*, there are studies on the reproduction, growth, feeding, distribution, behaviour and geographical movements (e.g. Crozier 1985; Landa et al. 2001; Laurenson et al. 2004; Laurenson et al. 2005; Landa et al. 2008; Velasco et al. 2008; Ofstad et al. 2013). According to those studies, *L piscatorius* is a large species that can attain up to 160 cm in total length (Landa et al. 2001). It is a sit-and-wait predator, which attracts preys by lure (illicia) casting (Laurenson et al. 2004). It is mainly icthyophagous but can also prey on invertebrates such as *Nephrops norvegicus* (Crozier et al. 1985; Laurenson et al. 2004). *L. piscatorius* can move throughout long distances, up to more than 400 km in 2 to 3 years, even crossing from the southern to the northern area of the Bay of Biscay or from the Shetland Islands to south Iceland (Laurenson et al. 2005; Landa et al. 2008). These authors, based on these movements, suggested that mixing of stocks is much more important than initially thought. The bathymetric movements are also important involving hundreds of meters to deep or shallower waters in relatively short periods of time (Landa et al. 2008). Studies on the growth of this species based on tagging experiments revealed that it apparently grows faster than initially reported from ring counts of transverse sections of illicium and section otoliths. According to those studies the eight year old individuals would have a mean total length around 80 cm.

In the Mediterranean the scarce information existing also indicates that *L piscatorius* increases its abundance northwards as in the Atlantic, with higher abundances in the Gulf of Lions (Ungaro et al. 2002). This species attains maturity at relatively large sizes, size at first maturity for females around 68 cm in total length, which using the growth parameters in Landa et al. (2008) is achieved at age 5-6. No local growth studies are available so far in this area. As for other species such as those in the Rajidae family, the improvement on the selectivity of bottom trawl gears in the Mediterranean, from 40 mm diamond to 40 mm square mesh in the codends, did not represent any improvement in the selectivity of *L. piscatorius*, for which retention is still complete using the square mesh (Ordines et al. 2015).

Because of the scarce information on the biology of *L. piscatorius* in the Mediterranean and the GSAs studied here, the growth parameters were taken from the Atlantic study by *Landa et al.* (2008). The values of the von Bertalanffy growth function (combining males and females) were: L_{inf} = 140 cm TL, k = 0.11 yr^{-1} (Figure 6.5.1.1.1). The length-weight relationship parameters were taken from García-

Rodriguez (2000), who used data collected from the MEDITS surveys in the GSA 6: a = 0.0182 and b = 2.932.
The proportion of mature individuals by age class was determined from the aged-based maturity ogive by sex provided by Duarte et al. (2001) and using the sex-ratio calculated from the MEDITS surveys in the GSAs studied (Figure 6.5.1.1.2). The resulting ogive used in the VPA analyses is presented in Table 6.5.1.1.1.

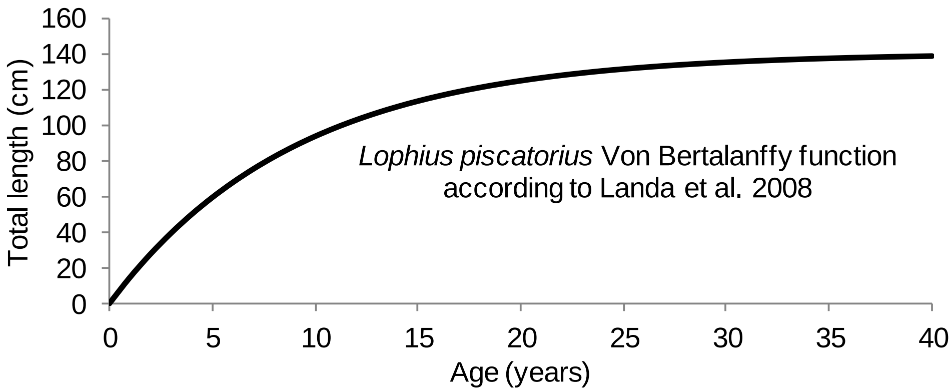


Figure 6.5.1.1.1 Anglerfish in GSAs 1,5,6 and 7. Von Bertalanffy growth function for *Lophius piscatorius* from Landa et al. 2008.

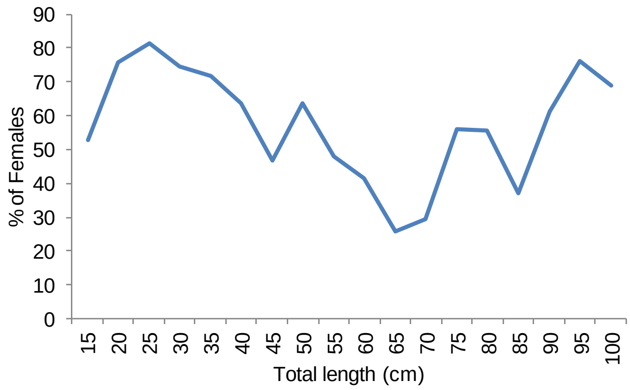


Figure 6.5.1.1.2 Anglerfish in GSAs 1,5,6 and 7. Sex ratio (% of females) obtained from MEDITS surveys' biological data on *Lophius piscatorius*.

Table 6.5.1.1.1 Anglerfish in GSAs 1,5,6 and 7. Maturity ogive obtained using ogives by sex provided by Duarte et al. (2001) and the sex-ratio from the MEDITS biological data for *Lophius piscatorius*

% Mature individuals											
Age	1	2	3	4	5	6	7	8	9	10	11
%	0.02	0.06	0.20	0.25	0.46	0.525	0.55	0.6	0.7	0.8	1

6.5.1.2 Catch data

The species is of secondary commercial importance in GSA 1, but regularly caught by bottom trawlers and to, a lesser extent, set nets (2-3% of the total landings in 2013). Most of the landings correspond to individuals between 20 and 50 cm TL which are often sold together with *L. piscatorius,* representing about 30% of the catches in the area for the last years.

In the Balearic Islands (GSA 5), commercial trawlers employ up to four different fishing tactics (Palmer et al. 2009), which are associated with the shallow and deep continental shelf, and the upper and middle continental slope (Guijarro and Massutí 2006; Ordines et al. 2006). Vessels mainly target striped red mullet (*Mullus sumuletus*), picarel (*Spicara smaris*) and octopus (*Octopus vulgaris*) on the shallow shelf, European hake (*Merluccius merluccius*) on the deep shelf, Norway lobster (*Nephrops norvegicus*) on the upper slope, and blue and red shrimp (*Aristeus antennatus*) in the middle slope. In this area one peculiarity of the bottom trawl fleet is that boats can exploit various depth strata even in the same day, which is a common operational routine (Palmer et al 2009).

In GSA 6, the main target stocks for fisheries on the continental shelf are European hake (*Merluccius merluccius*) and red mullet (*Mullus barbatus*); while in deeper waters same crustaceans as in GSA 5, with high price, are targeted. Another important aspect of the mixed demersal fisheries are the mobility of fleets along the depth range: while smaller vessels (VL 1218 and smaller, i.e. small scale fleet and small trawlers) tend to restrict their activity to the continental shelf, large trawlers fish from 50 to 1000 m depth, varying their fishing strategy along the year (depending on fish availability, market or weather).

Demersal fisheries in GSA 7 (Gulf of Lions) are carried with variety of fishing gear, mainly bottom and pelagic trawl, gillnets, trammel nets and longlines. The largest share of the fisheries production in GSA07 is due to French vessels, but the production of Spanish bottom trawlers and longliners in GSA07 is non-negligible.

Due to the low abundance of the Monk fish (*L. piscatorius*) population in the GSA 1, the landings are scarce and the data on length frequencies were very poor for all the years.

In the GSA 5, *L. piscatorius,* is typically a by-catch species from the bottom trawl fishery. As in the rest of GSAs this fishery takes two different anglerfish species (*L. budegassa* and *L. piscatorius*) which are sold in a single commercial category.

In GSA 06 the fishery is carried out with a variety of fishing gear, classified for statistical purposes as fleet segments, although the bulk of fisheries production are obtained by the largest segments of bottom trawl vessels. It is important to note that demersal fisheries in GSA 06 are of mixed nature: continental shelf fisheries are complemented with a few dozens of other commercial species.

In the GSA 07 (Gulf of Lions) the fishery is carried out with variety of fishing gear, mainly bottom and pelagic trawl, gillnets, trammel nets and longlines. The largest share of the fisheries production in GSA07 is due to French vessels, but the production of Spanish bottom trawlers and longliners in GSA07 is non-negligible.

In the DCF 2016 data set the two species are reported separately, with commercial landings apportioned to *L. piscatorius* or *L. budegassa*. The trend for both species in the landings (Figure 6.5.1.2.2) seems to be quite similar to that from MEDITS surveys (Figure 6.5.1.2.3) suggesting that both species have been correctly identified in the landings. During 2002-2015 the annual landings of *L. piscatorius* have a stable trend with an increasing in 2011, decreasing thereafter. In the total series, landings oscillated between 280 and 1000 tons (Figure6.5.1.2.2).

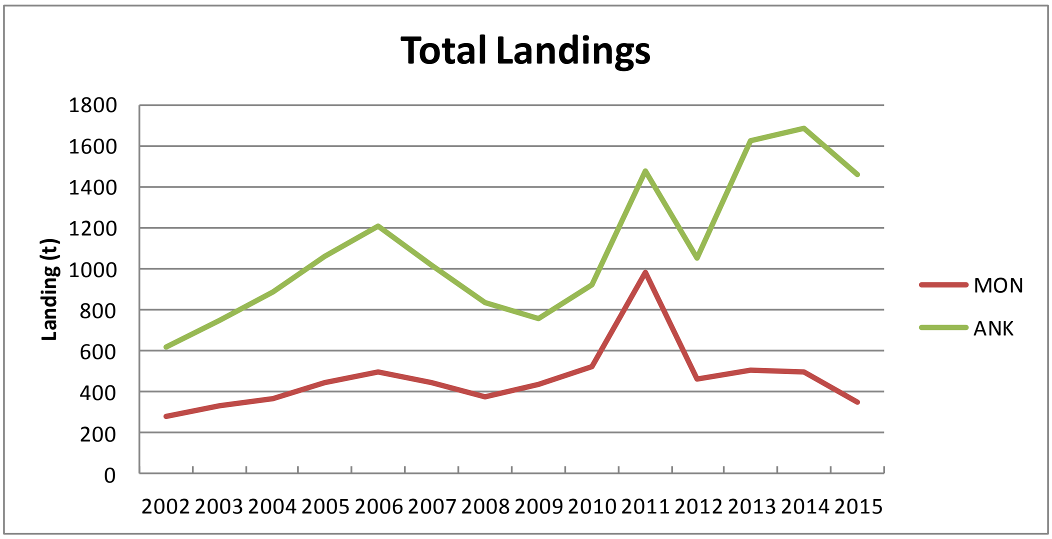


Figure 6.5.1.2.2 Anglerfish in GSAs 1,5,6 and 7. Commercial landings of anglerfishes from all GSA combined (1, 5, 6, and 7) and all gears. (ANK: *Lophius budegassa*; MON: *Lophius piscatorius*).

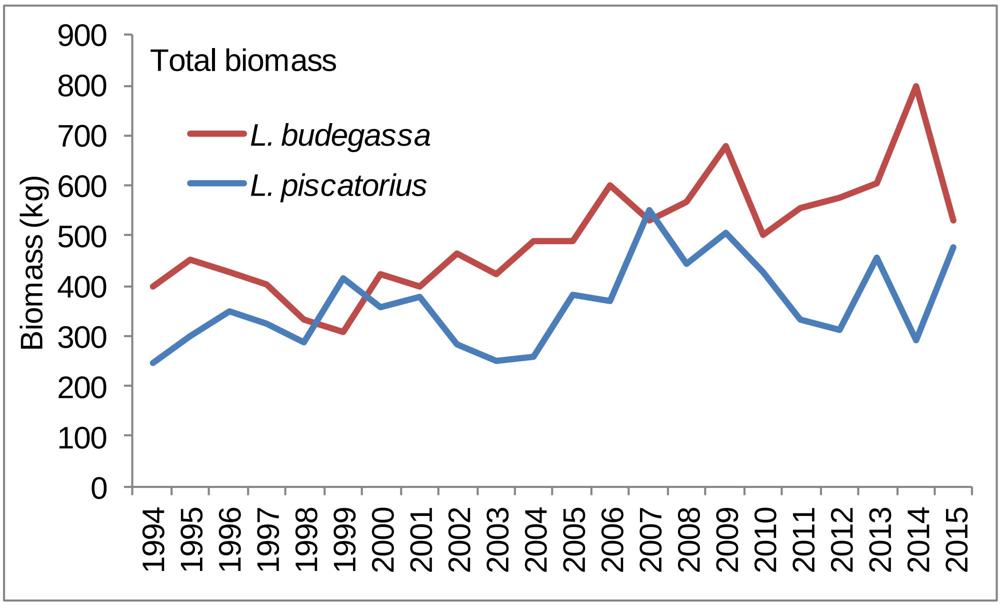


Figure 6.5.1.2.3 Anglerfish in GSAs 1,5,6 and 7. Total catches of anglerfishes from all GSA combined (1, 5, 6, and 7) during the annual MEDITS surveys from 1994 to 2015. (ANK: *Lophius budegassa*; MON: *Lophius piscatorius*)

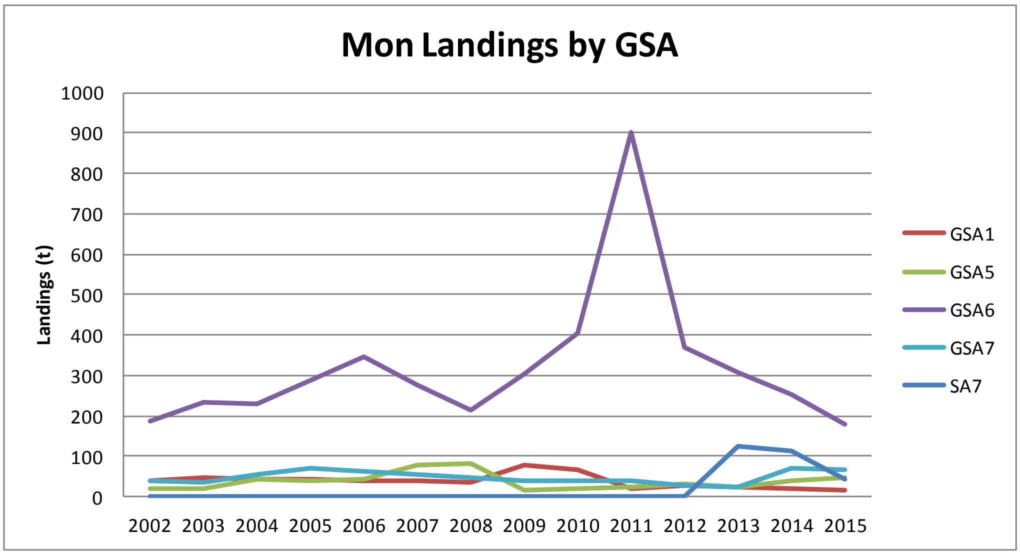


Figure 6.5.1.2.4 Anglerfish in GSAs 1,5,6 and 7. Landings of *Lophius piscatorius* from GSAs 1, 5, 6 and 7 during the period 2002-2015. SA 7 distinguishes the French fleet landings from GSA7 from the Spanish fleet ones (GSA7).

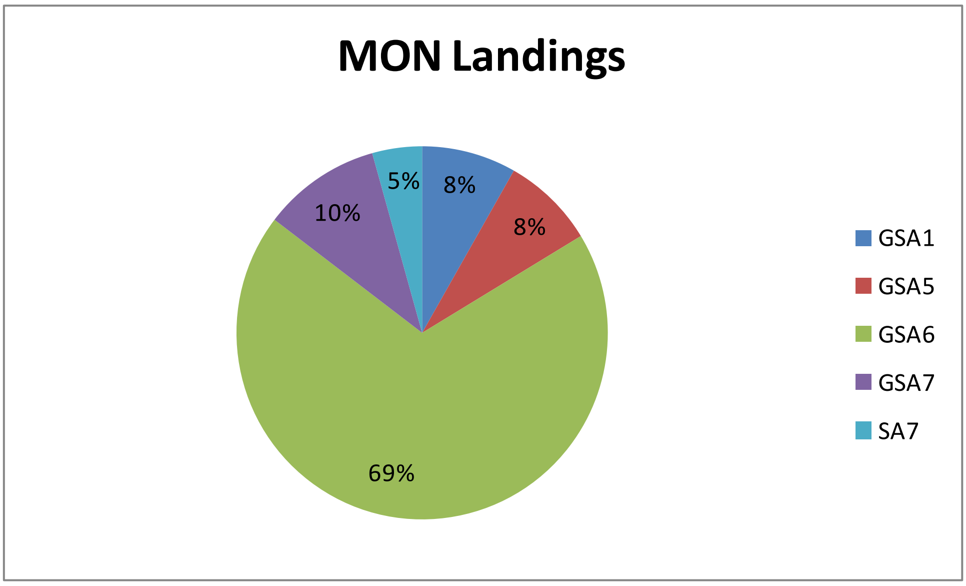


Figure 6.5.1.2.5 Anglerfish in GSAs 1,5,6 an d7. Mean percentage of landings of *Lophius piscatorius* corresponding to each GSA in the period 2002-2015.

Considering the different GSAs involved, GSA 6 reported the largest percentage of the landings, 70% in average, followed by the GSA 7, with 15 % (GSA 7+SA 7) and GSA 5 and 1 both with 8%.

Table 6.5.1.2.2 Anglerfish in GSAs 1,5,6 and 7. Landings of *Lophius piscatorius* by fishing gear from DCF 2016 data call. Catches made by set nets were not reported for most of the time series and very low when reported (the last three years). LLS: longlines; OTB: Otter bottom trawl.

Year	LLS	OTB
2002	0.7	281.8

2003	0.9	331.6
2004	0.9	364.6
2005	1.0	442.1
2006	0.7	494.4
2007	0.7	442.9
2008	0.6	375.7
2009	1.2	433.1
2010	1.1	523.1
2011	1.4	982.4
2012	0.6	459.2
2013	2.2	454.7
2014	8.6	422.2
2015	2.5	336.9

Discards of monkfish are considered small and few were reported in the DCF 2016 data call and thus they were not included in the assessment. Anyhow, there are no length frequencies of these discards because Spain makes use of the derogation in the Commission Regulation (EC) No 1581/2004 which does not oblige the MS to collect detailed discard data for this species due to the low level of landings.

Table 6.5.1.2.3 Anglerfish in GSAs 1,5,6 and 7. Percentage of discards of *Lophius piscatorius* from all GSA combined (1, 5, 6, 7), calculated from DCF 2016 data call.

Year	Discards %
2002	0
2003	0
2004	0
2005	6.6
2006	0
2007	0
2008	0.9
2009	0.4
2010	0.7
2011	5.5
2012	1.7
2013	0.8
2014	2.3
2015	1

6.5.1.3 Fishing effort data

Trawl (OTB) fishing effort data for GSAs was submitted by quarter, area, gear, fishery and vessel length class for the years 2009-2015 in the 2016 data call. Both the number of vessel and the effort of OTB fleet in the GSAs considered for the period 2009-2015, shows a reduction in fishing effort and number of vessels. (Figure6.5.1.3.1, Table 6.5.1.3.1).

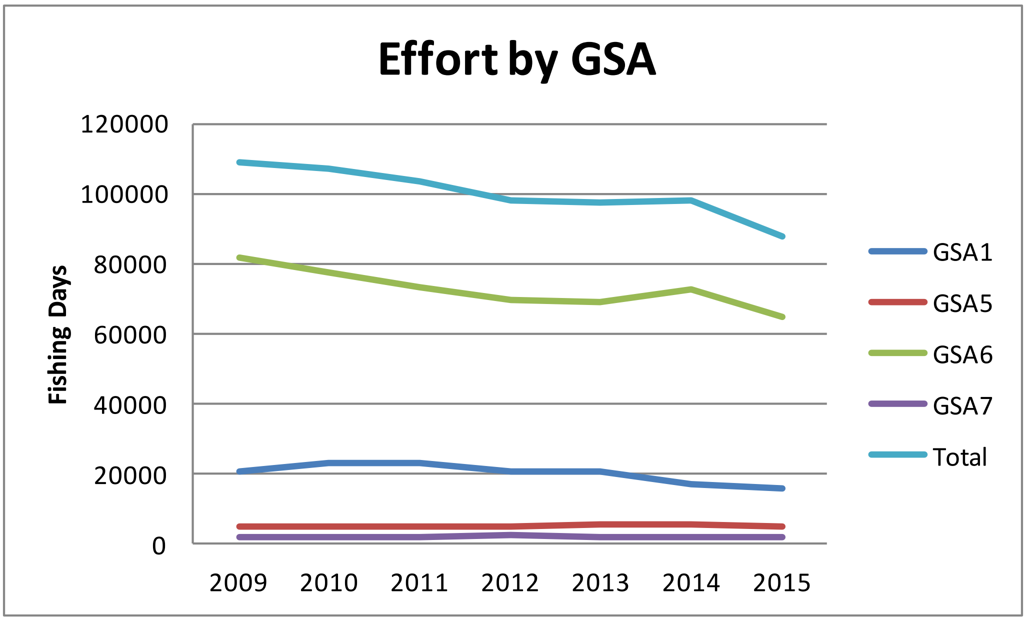


Figure 6.5.1.3.1 Anglerfish in GSAs 1,5,6 and 7. Evolution of the fishing effort of the bottom trawl fleet in each GSA considered from 2009 to 2015.

Table 6.5.1.3.1 Anglerfish in GSAs 1,5,6 and 7. OTB effort: Fishing days, nominal effort and GT during 2009-2015.

Year	fishing_days	nominal_effort	gt_days_at_sea	number vessels
2009	109136	25631202	5814643	2985
2010	107249	25043745	5725725	2452
2011	103250	23873851	5458243	2752
2012	98040	22508733	5205605	2652
2013	97208	21971959	5168983	2582
2014	97864	22141307	5165332	2500
2015	87539	19449311	4565696	2368

6.5.1.4 Survey Indices of abundance and biomass by year and size/age

The MEDITS surveys are carried out annually during spring-summer since 1994 in most GSA. It is the case of the MEDITS data analyzed for all GSA included in this report except the GSA 5 (Balearic Islands) where the MEDITS surveys began in 2007.

Trends in abundance and biomass

The different GSAs did not show any clear trend in their mean standardized abundance during the time series analyzed, neither for all GSAs combined. GSA 5 and 7 showed the largest fluctuations whereas the rest of GSAs remained fairly stable (Figure 6.5.1.4.1).

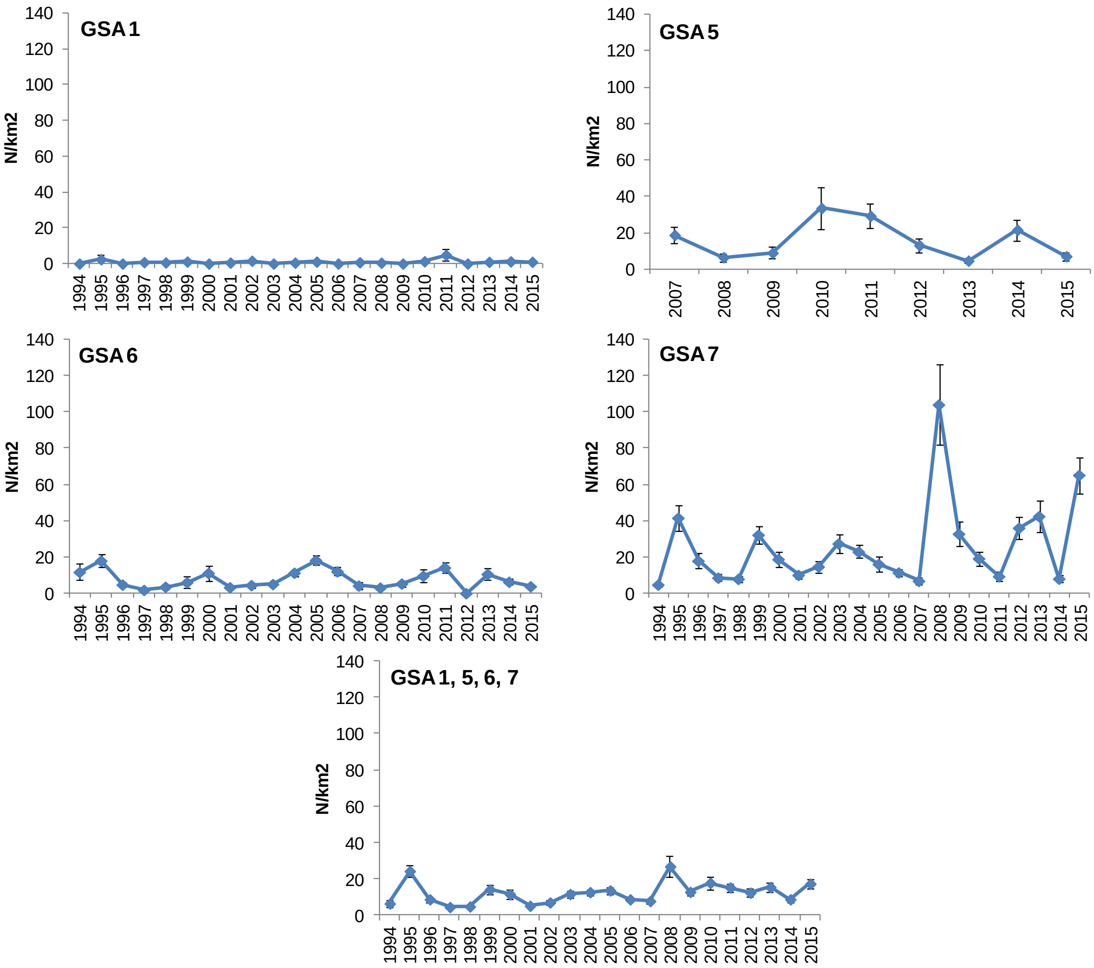


Figure 6.5.1.4.1 Anglerfish in GSAs 1,5,6 and 7. Mean annual standardized abundance (N/km^2 ± S.E.) of *Lophius piscatorius* from the MEDITS surveys during 1994-2015. For the combined series the period prior to 2007 is based on mean abundance in GSA 1, 6, 7 only.

The time series of biomass (Figure 6.5.1.4.2) showed a similar plot to that of the abundance, except for GSA 5 which increased from 2008 to 2010 but is decreasing since then.

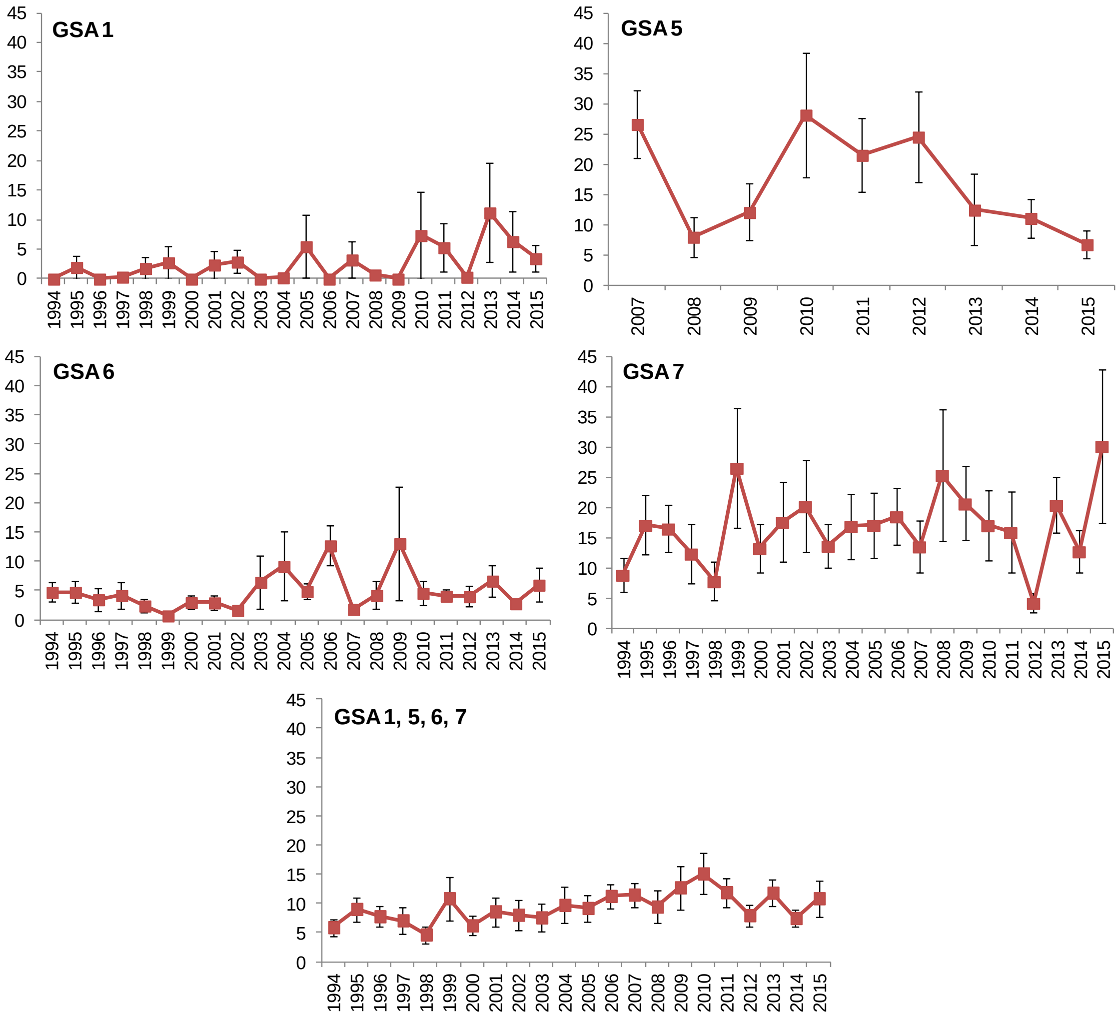


Figure 6.5.1.4.2 Anglerfish in GSAs 1,5,6 and 7. Mean annual standardized biomass (kg/km^2 ± S.E.) of *Lophius piscatorius* from the MEDITS surveys during 1994-2015. For the combined series the period prior to 2007 is based on mean biomass in GSA 1, 6, 7 only.

Geographical distribution of the abundance

For all the years, *L. piscatorius* showed the same geographical pattern of distribution: an increasing abundance northwards. Minimum standardized abundances (N/km2) by haul were detected in the Alboran Sea (GSA 1), with abundances increasing to the north until they reach the highest values (200 and 400 individuals/km^2) in the Gulf of Lions (GSA 7) where most of the hauls with the highest values are concentrated (Figure 6.5.1.4.3). The abundance was also higher in the Balearic Islands than in the adjacent areas of the Peninsula.

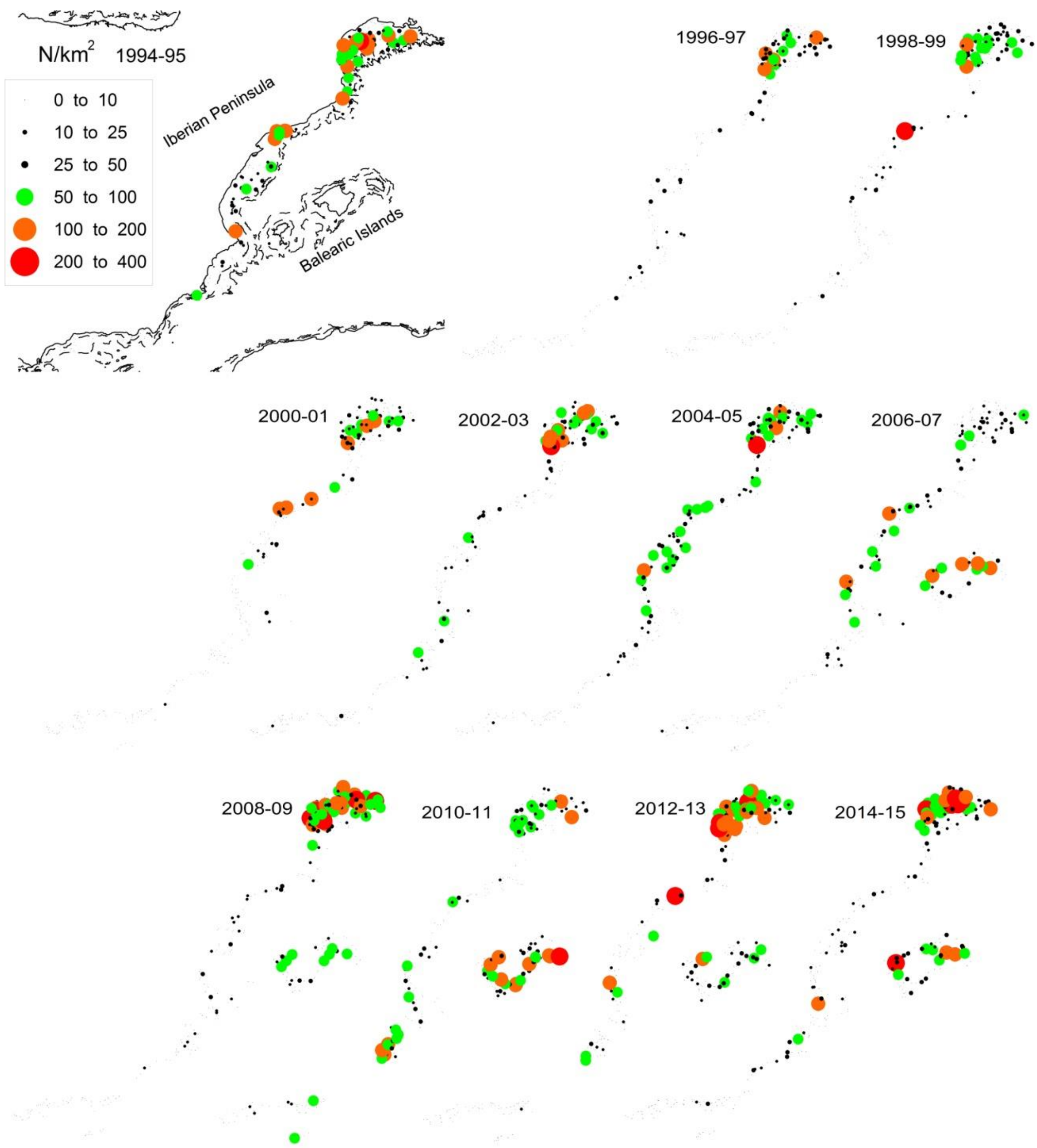


Figure 6.5.1.4.3 Anglerfish in GSAs 1,5,6 and 7. Biannual maps showing the standardized abundance (N/km^2) of *Lophius piscatorius* by haul. The isobaths, only represented in the first map of the time series, are 200 and 800 m depth.

Length distributions and size trends

The mean length distributions of the neighbor GSAs 6 and 7 were very similar, with most individuals concentrated in the 0 to 40 cm intervals (Figure 6.5.1.4.4). In GSA 5 most of the population was concentrated in the 10 to 50 interval, whereas the low number of individuals caught from the GSA 6 resulted in an unreliable length distribution even pooling all the years.

Due to the low number of individuals in GSA 1 and the late beginning of MEDITS surveys in GSA 5, the evolution of the mean length and mean maximum length were calculated pooling all samples from all GSAs but GSA 5. No trend was observed neither for the mean length nor for the mean maximum length, calculated as the average of the maximum lengths in each MEDITS haul (Figure 6.5.1.4.5).

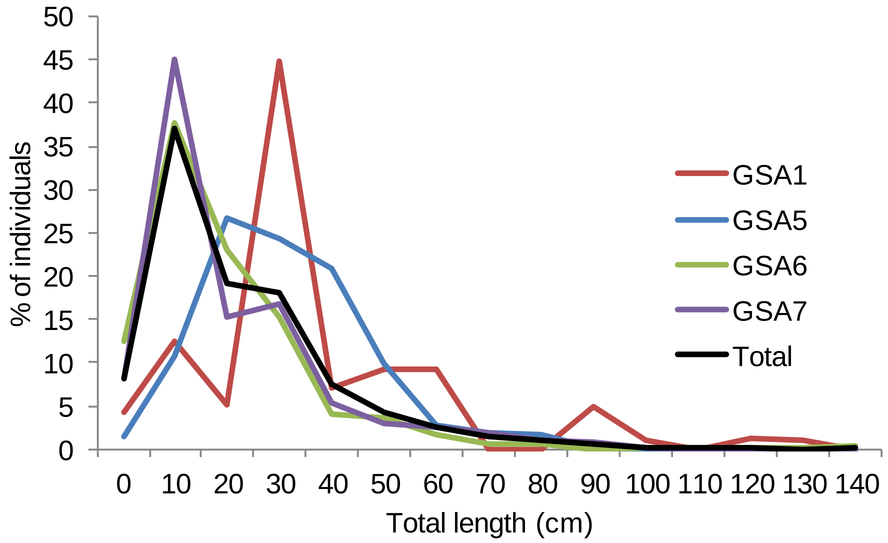


Figure 6.5.1.4.4 Anglerfish in GSAs 1,5,6 and 7. Mean length distributions for the time series of MEDITS surveys from 1994 to 2015.

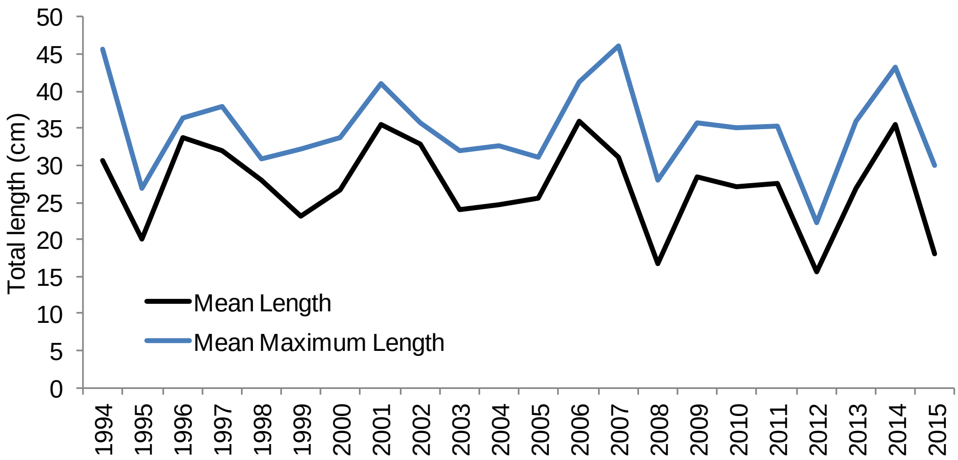


Figure 6.5.1.4.5 Anglerfish in GSAs 1,5,6 and 7. Mean and mean maximum lengths throughout the time series of MEDITS surveys from 1994 to 2015. The data from GSA 5 was excluded for the as MEDITS data in that area started in 2007.

Geographical distribution of the mean individual weight

For all the years, *L. piscatorius* showed the largest values of mean individual weight in the hauls farther from the shore, in the slope bottoms. At the beginning of the MEDITS series, the largest values exclusively appeared in the Gulf of Lions (GSA 7), whereas it seems that the presence of large individuals is spreading to the south during the last years, particularly to the southern part of the GSA 6 and the northern part of GSA 1 (Figure 6.5.1.4.6). The occurrence of high values of mean individual weight was also detected in the Balearic Islands, in the slope bottoms as well.

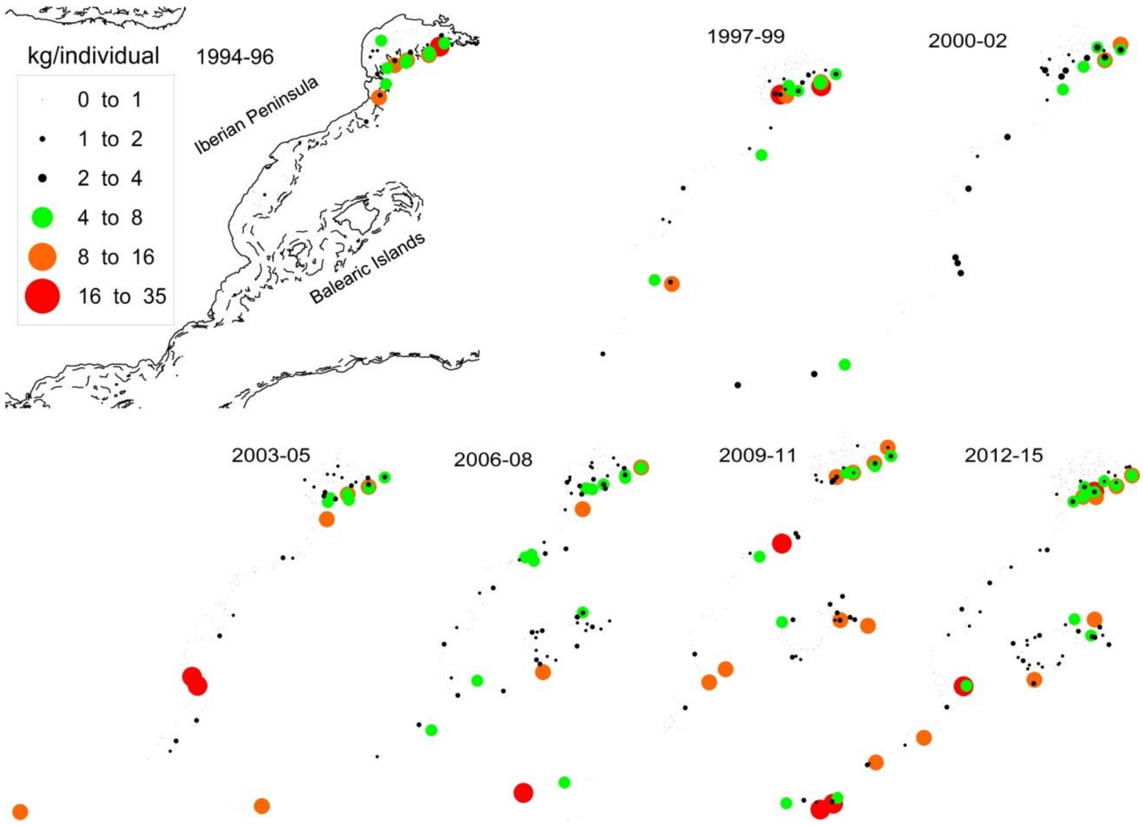


Figure 6.5.1.4.6 Anglerfish in GSAs 1,5,6 and 7. Three-year grouped maps of MEDITS hauls showing the mean individual weight of *Lophius piscatorius* by haul. The isobaths, only represented in the first map of the time series, are 200 and 800 m depth.

Trends in the abundance of immature and mature individuals

No trend was detected in the abundance of mature or immature individuals (calculated using the maturity ogive in Duarte et al. 2001) in relation to the mean abundance during the initial reference period of the MEDITS surveys (1994-1998). A peak appeared in 2007 for the immature population, probably indicating an exceptional year in the recruitment success. On the other hand, the population of matures showed the lowest values in the last years of the time series (2012 and 2014), however, the evolution of this fraction of the population (or the catchability) seems to be very variable and more years would be needed to see if it represents the beginning of a decline of this fraction (Figure 6.5.1.4.7).

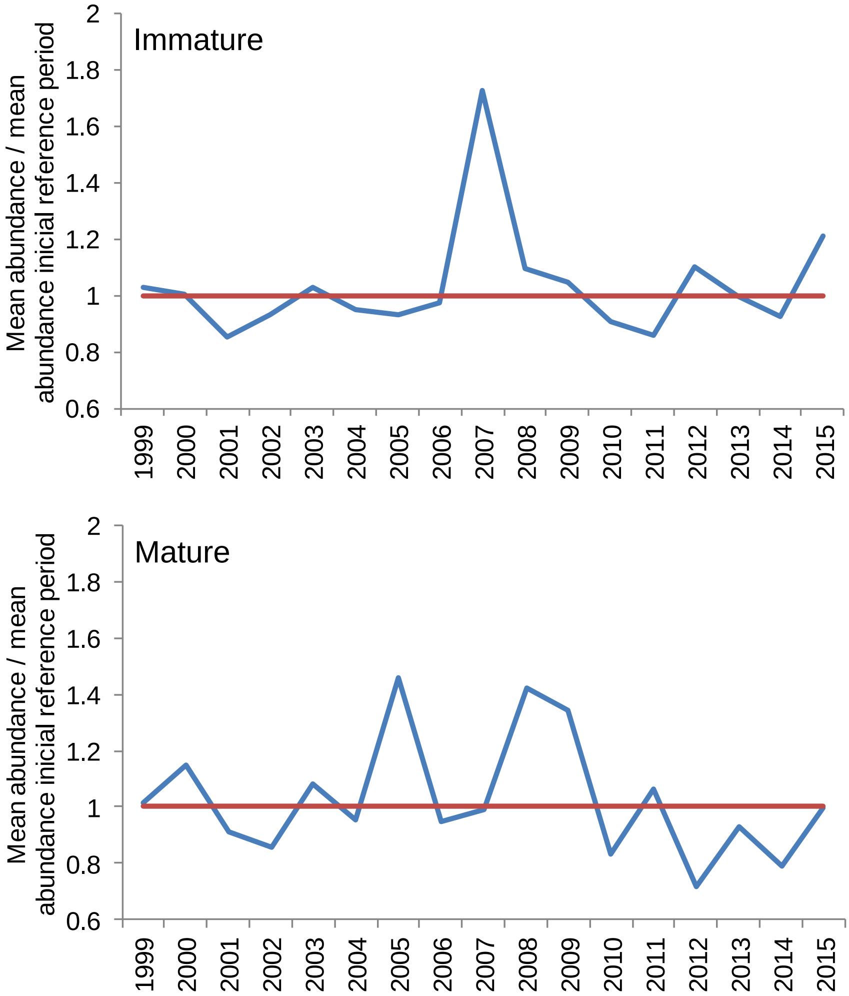


Figure 6.5.1.4.7 Anglerfish in GSAs 1,5,6 and 7. Mean abundance of immature and mature individuals in relation to the mean of the initial period of reference (MEDITS surveys from 1994 to 1998, indicated as a red horizontal line).

Bathymetric distribution

The bathymetric distribution abundance, probability of presence and mean individual weight were calculated by pooling MEDITS hauls every 20 m depth. It must be taken into account that hauls on the shelf have a shorter duration (30') than on the slope (60'), and hence, the occurrence may be underestimated in relation to that on the slope. In any case the abundance shows its maximum on the shelf, which would prevent high deviations on occurrence due to haul duration.

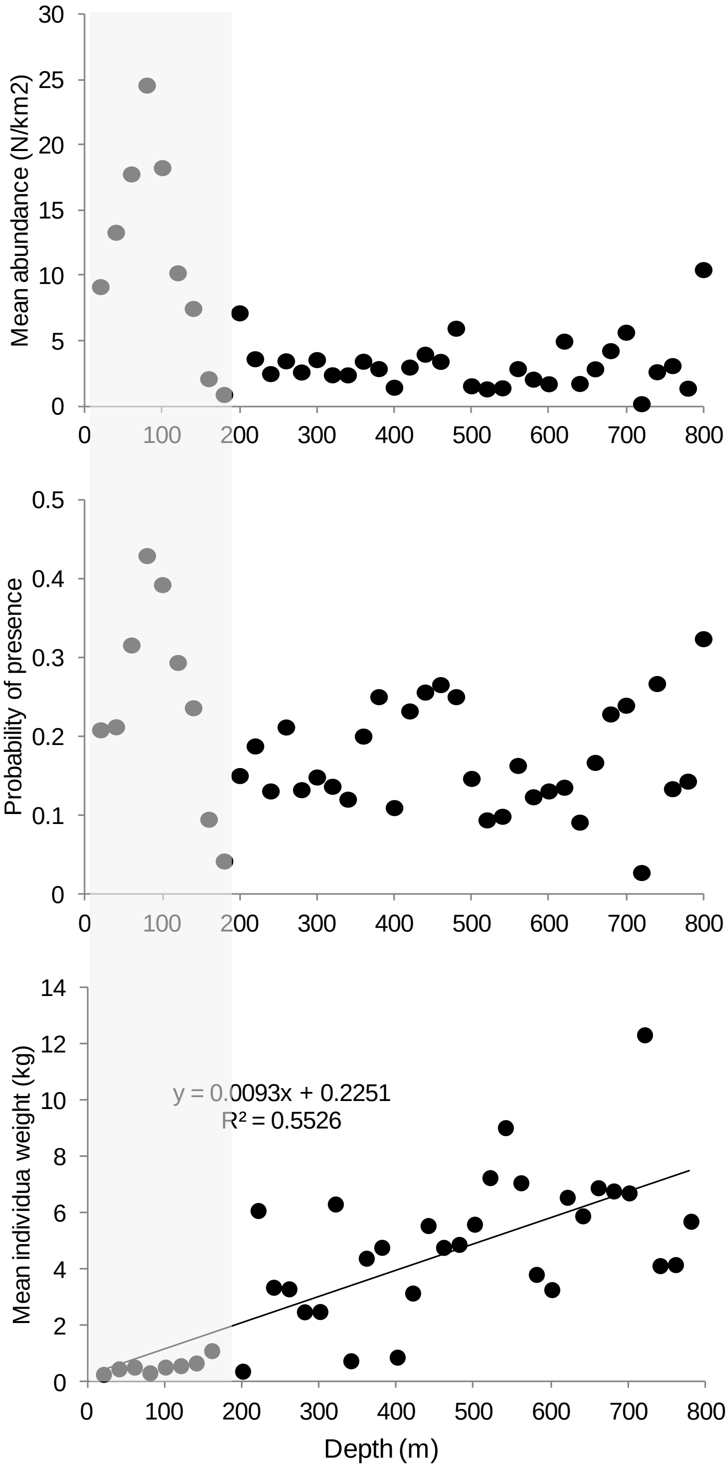


Figure 6.5.1.4.8 Anglerfish in GSAs 1,5,6 and 7. Bathymetric distribution of the mean abundance, probability of occurrence and mean individual weight of *Lophius piscatorius* calculated from the MEDITS surveys and all GSAs combined (1, 5, 6, and 7).

A peak around 80-120 m depth appeared for both mean abundance and probability of occurrence (Figure 6.5.1.4.8). The shaded area in the graph encompasses the continental shelf bottoms, and allows relating the highest values of abundance and probability of occurrence with the presence of the smallest individuals (less than 1 kg of mean weight).

Abundance and probability remain fairly constant around 2-4 individuals/km2 and 0.1-0.25, respectively, deeper than 200 m depth, without any perceptible decrease, indicating that the distribution of the population extends at deeper bottoms than those sampled in the MEDITS surveys (and those exploited by the bottom trawl fleet). The mean individual weight showed a significant increasing trend for the bathymetric range sampled, suggesting that the population inhabiting deeper than the bottoms sampled in the MEDITS surveys, i.e. deeper than the bottom trawl fishery, corresponds to the largest individuals. The length distribution of *L. piscatorius* by MEDITS depth strata also shows the same trend, with individuals larger than 65 cm almost only present in the upper and middle slope (Figure 6.5.1.4.9).

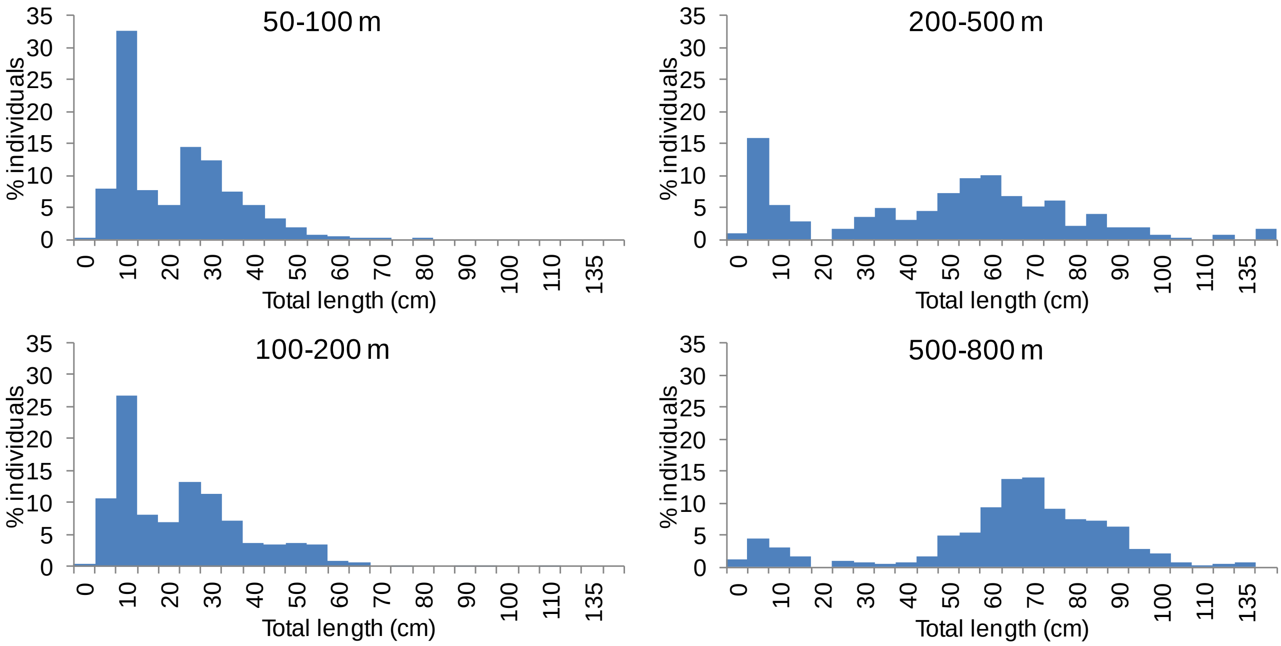


Figure 6.5.1.4.9 Anglerfish in GSAs 1,5,6 and 7. Length distributions of *Lophius piscatorius* by MEDITS depth strata, calculated from all GSAs combined (1, 5, 6 and 7).

6.5.2 STOCK ASSESSMENT ON ANGLERFISH IN GSAs 1, 5, 6 AND 7

Method (VIT)

Due to the low quality of data provided for the different GSAs, only the last three years were considered as acceptable to be used as input for the assessment (2013, 2014 and 2015). These were the years with available landings for all GSAs considered, because GSA 7 landings data from the French fleet are only available since 2013. For these years the length frequency distribution also appeared to be more reliable. Only the data from bottom trawl was used, because it represented on average the 95% of the landings, with the other gears presenting variable length distributions.

The assessment was based on a pseudocohort analysis using the VPA equations, and was carried out using the VIT software (Lleonart and Salat, 1992). This model assumes equilibrium conditions. The use of this software is only recommended when the model is applied to short time series of consecutive annual data and the resulting variation in the estimated stock parameters appears reasonably low. (Ratz et al, 2010).

Input parameters

The data used in the assessment were: (i) Landings time series 2013-2015 from OTB; (ii) Age distributions obtained from slicing of length distributions 2013-2015 (Figure 5.2.2.6.3.1) using the von Bertalanffy growth parameters from Landa et al. (2008); (iii) Natural mortality vector (calculated using PRODBIOM; Abella et al. 1997); (iv) Maturity ogive (determined from the aged-based maturity ogive by sex provided by Duarte et al. (2001) and using the sex-ratio calculated from the MEDITS surveys) and; (v) the length-weight relationship parameters from García-Rodríguez (2000).

Table 6.5.2.2.1 Anglerfish in GSAs 1,5,6 and 7. Input parameters: maturity ogive and M (natural mortality) by age class.

Age class	Maturity	M
0	0	1.07
1	0.02	0.57
2	0.06	0.38
3	0.205	0.33
4	0.25	0.30
5	0.46	0.28
6	0.525	0.27
7	0.55	0.27
8	0.6	0.27
9	0.7	0.27
10	0.8	0.27
11	1	0.27

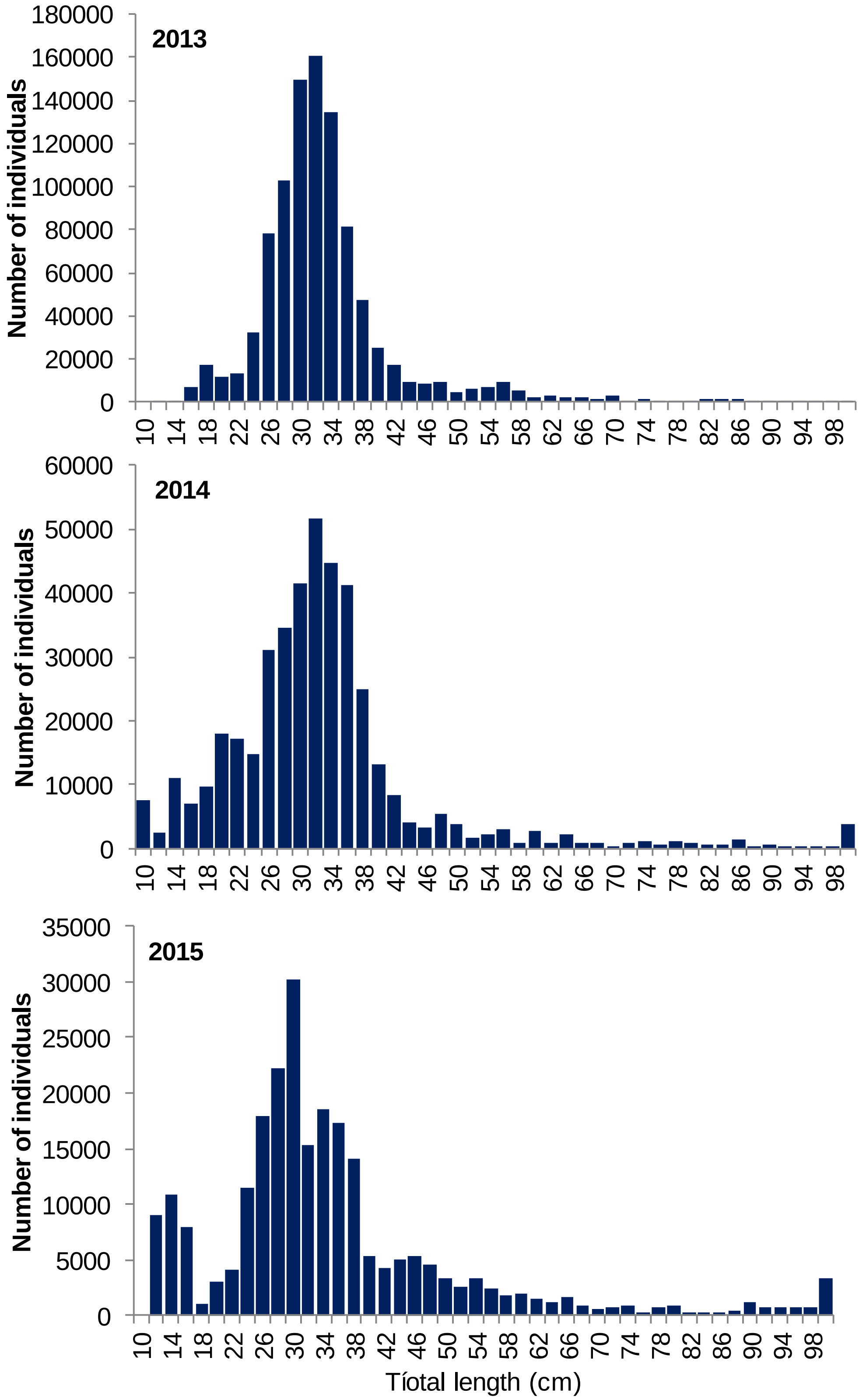


Figure 6.5.2.2.1 Anglerfish in GSAs 1,5,6 and 7. Annual pseudocohorts size distribution.

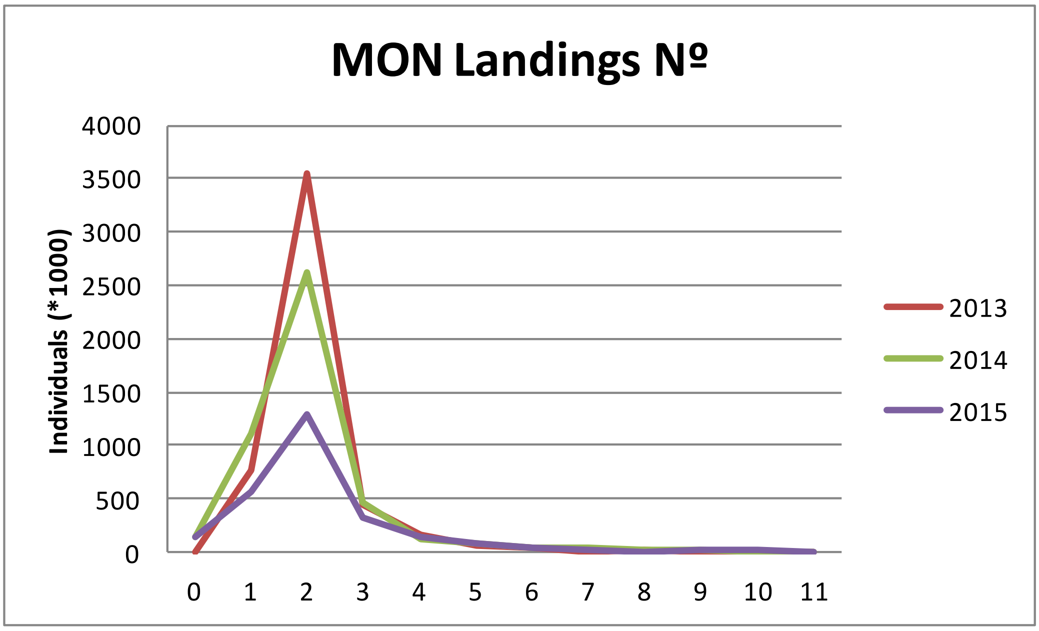


Figure 6.5.2.2 Anglerfish in GSAs 1,5,6 and 7. Age class contribution (in number of individuals) to the commercial landings by year.

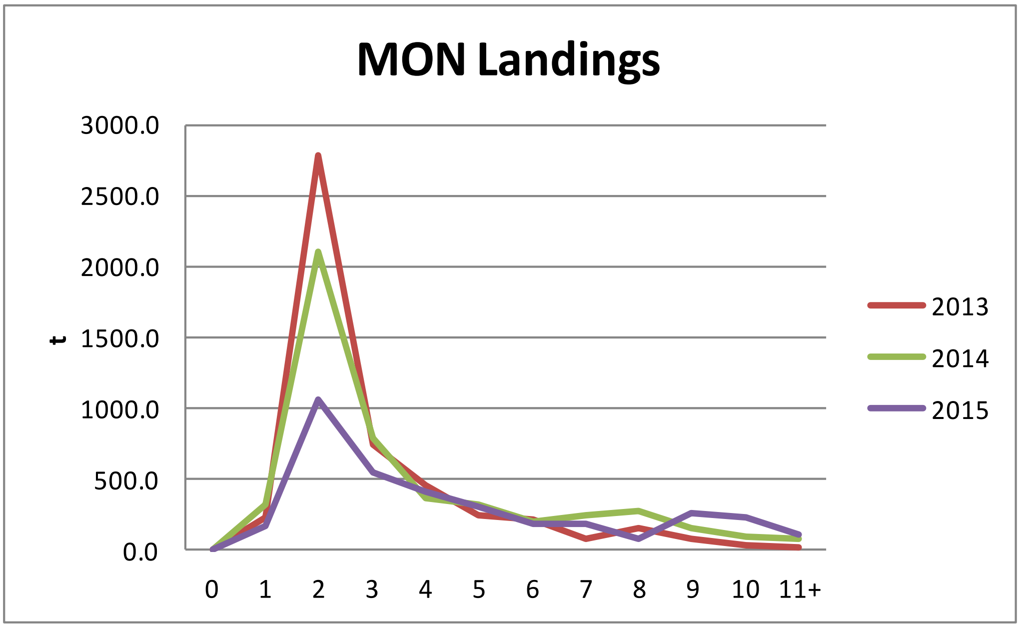


Figure 6.5.2.3 Anglerfish in GSAs 1,5,6 and 7. Age class contribution (in weight) to the commercial landings by year.

The catches were dominated by age classes 1 to 4 in all three years, with higher catches of age class 2 in 2014 that decreased in 2014 and 2015 (Figure 6.5.2.2 and Figure 6.5.2.3). The catches of the rest of age classes remained fairly constant for the three years considered.

Results

Three independent annual VIT assessments were carried out in 2013, 2014 and 2015. Results of pseudocohort VPA analysis showed a decreasing trend in the number of recruits (R) from 2013 to 2015. On the contrary, Biomass (B) and Spawning stock biomass (SSB) showed an increasing trend in the considered years. The fishing mortality decreased from 2013 to 2015. (Table. 6.5.2.2).

Table. 6.5.2.2 Anglerfish in GSAs 1,5,6 and 7. Summary results of the VPA analysis for the Monk fish (*Lophius piscatorius*).

Parameter	2013	2014	2015
R (thousands individuals)	2051	1941	1269
B (t)	1010	1313	1252
SSB (t)	181	334	391
Recruitment (%)	2.3	2.1	1.7
Growth (%)	97.7	98	98.3
Natural death (%)	47.6	52	57
Fishing (%)	52.4	48	43

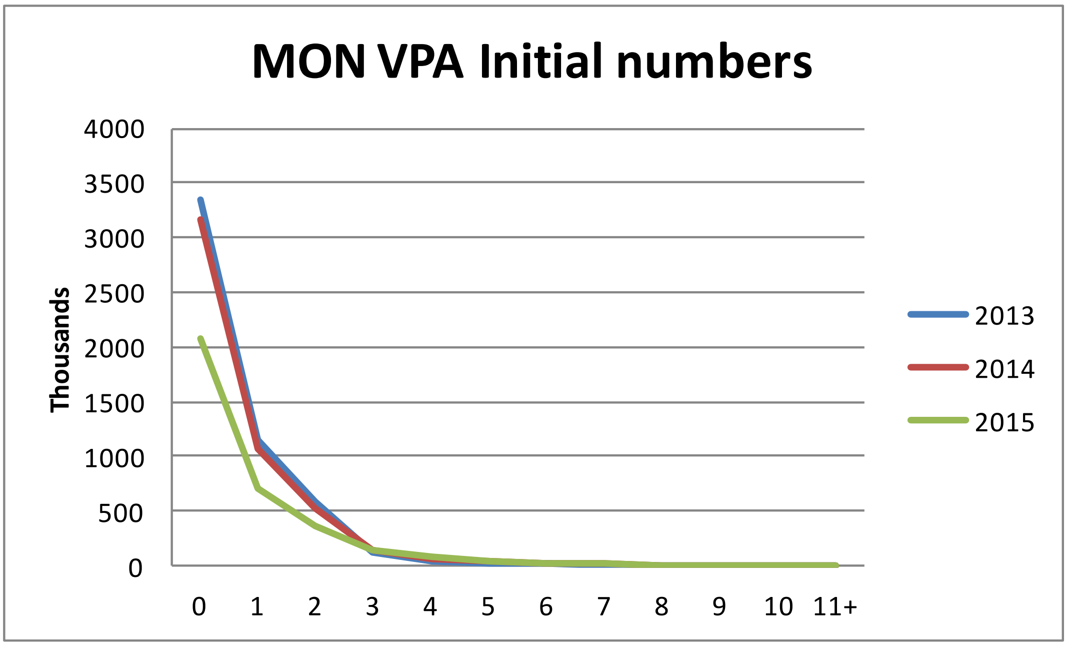


Figure 6.5.2.4 Anglerfish in GSAs 1,5,6 and 7. Initial numbers for each age class for the period 2013-2015.

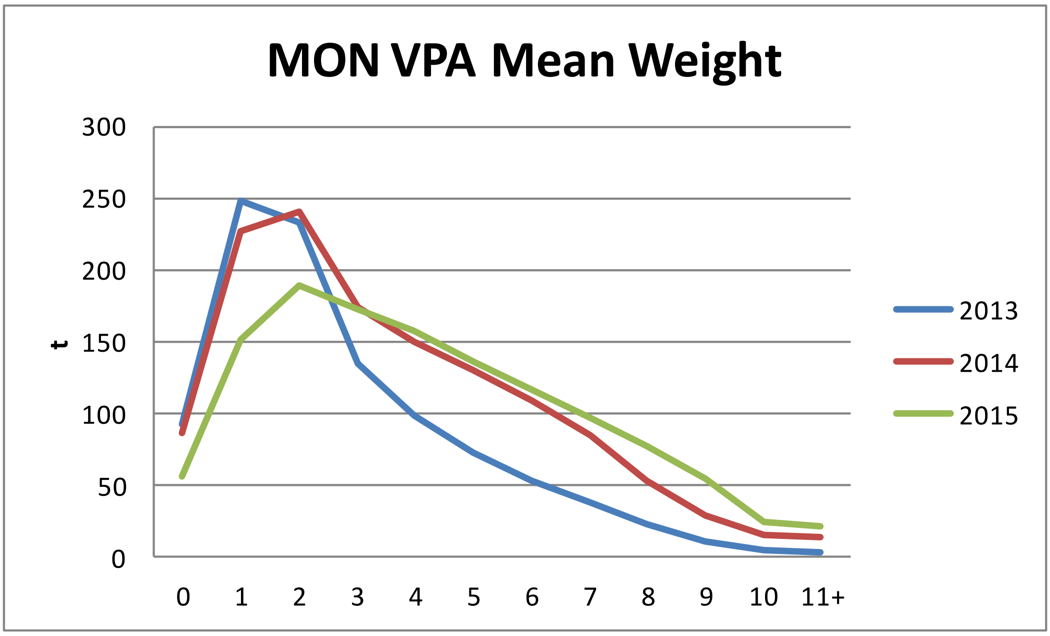


Figure 6.5.2.5 Anglerfish in GSAs 1,5,6 and 7. Mean weights for each age class for the period 2013-2015.

Fishing mortality values were different for the different age classes present in the exploited population (1 to 11+). The fishing mortality focuses mainly on ages 2-4, and is also high for the older ages because of the use of a Plus Class that shrinks and concentrates F values of individuals bigger than 100 cm long.

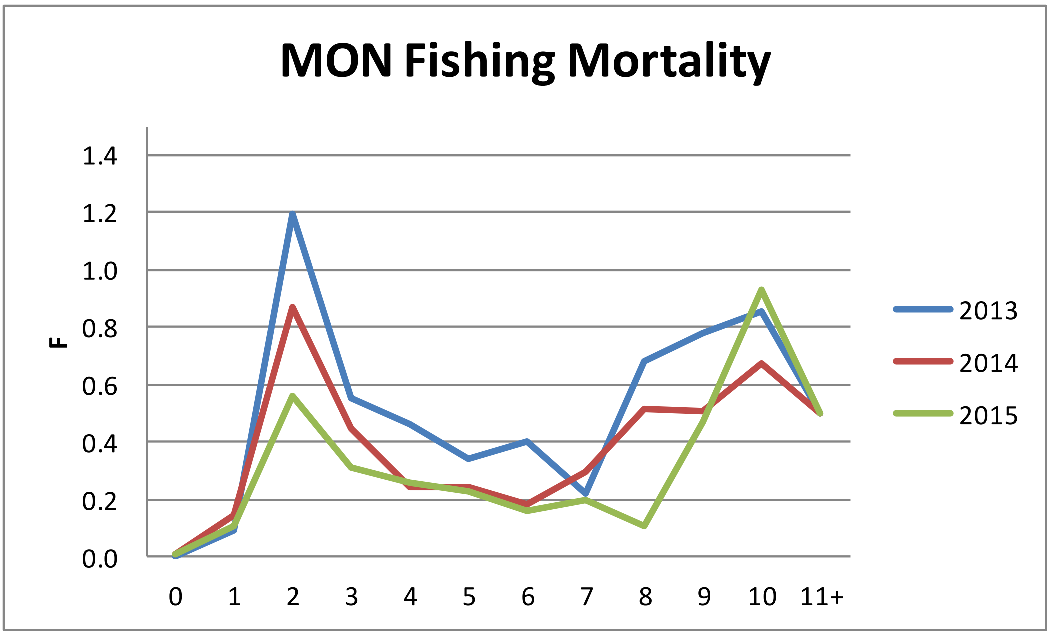


Figure 6.5.2.6 Anglerfish in GSAs 1,5,6 and 7. Fishing mortality for each age class for the period 2013-2015.

Table 6.5.2.2.3 Anglerfish in GSAs 1,5,6 and 7. Summary results of the Yield per Recruit analysis (Y/R) for the Monk fish (*Lophius piscatorius*).

Slope at origin	**Virgin biomass**	**Method**	**Num_points**	**Resolution**
1524.7471	1.03E+10	Mean weight from VPA	200	0
2013				
___	**Factor**	**Y/R**	**B/R**	**SSB**
F(0)	0	0.0	3077.2	1930.0
$F_{0.1}$	0.27	169.4	1203.4	542.0
F_{MAX}	0.44	178.2	780.5	284.1
phi=1	1.01	159.0	311.5	55.4
phi=2	2	140.3	162.6	8.9
Slope at origin	**Virgin biomass**	**Method**	**Num_points**	**Resolution**
1222.6478	9757250058	Mean weight from VPA	200	0
2014				
___	**Factor**	**Y/R**	**B/R**	**SSB**
F(0)	0	0.0	3077.2	1930.0
$F_{0.1}$	0.33	166.0	1271.4	586.1
F_{MAX}	0.54	174.7	837.6	319.9
phi=1	1.01	161.3	423.3	107.3
phi=2	2	135.9	187.5	18.3
Slope at origin	**Virgin biomass**	**Method**	**Num_points**	**Resolution**
1064.2968	6388584499	Mean weight from VPA	200	0
2015				
___	**Factor**	**Y/R**	**B/R**	**SSB**
F(0)	0	0.0	3077.2	1930.0
$F_{0.1}$	0.39	169.5	1373.6	637.0
F_{MAX}	0.66	179.7	920.2	356.2
phi=1	1.01	173.5	612.8	191.6
phi=2	2	147.7	273.4	44.6

Method 2. Length-based analysis

Length-based methods were used for deriving some indicators explored in WKLIFE IV. (ICES, 2015). They allow classifying the stocks according to conservation/sustainability, yield optimization and MSY considerations. Analysis required data on the stock catch/landings–length composition and life-history parameters as Linf.

The length-based indicators analysis was performed using the commercial landings in 2013to 2015 (discards considered negligible) and the following life-history parameters based on the specific sex ratio found in the area: Linf=140 cm..

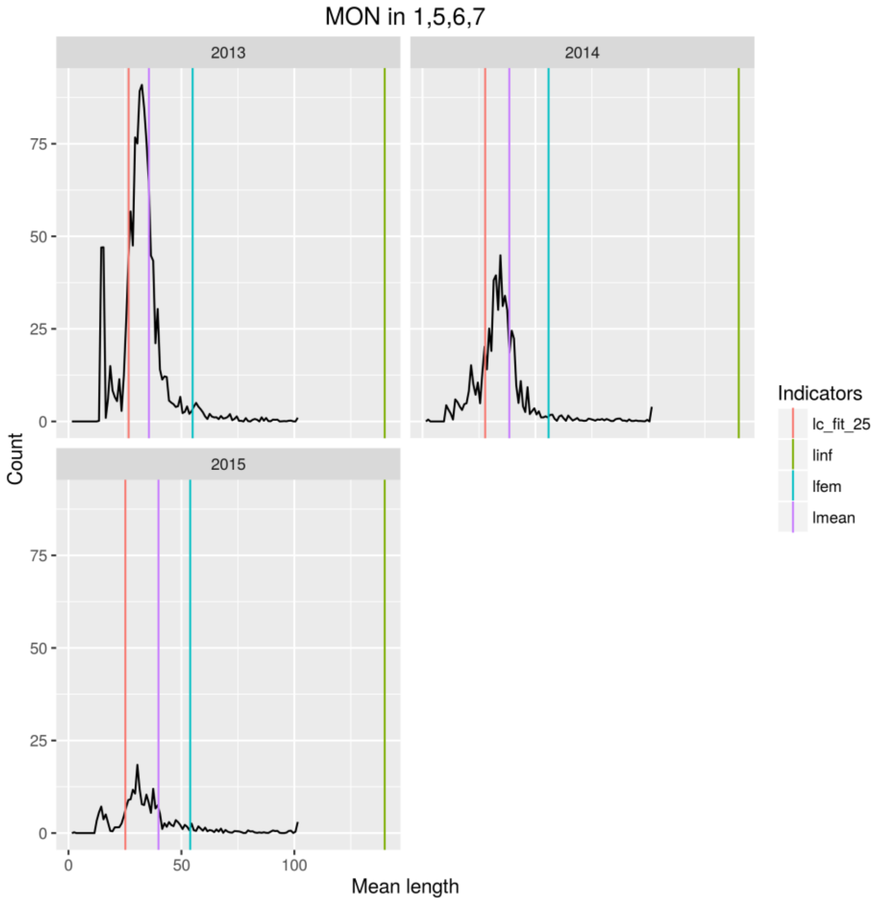


Figure 6.5.2.7. Anglerfish in GSA 1, 5, 6 and 7. Length-based indicators and reference points for anglerfish using the catch length composition for 2013, 2014, 2015

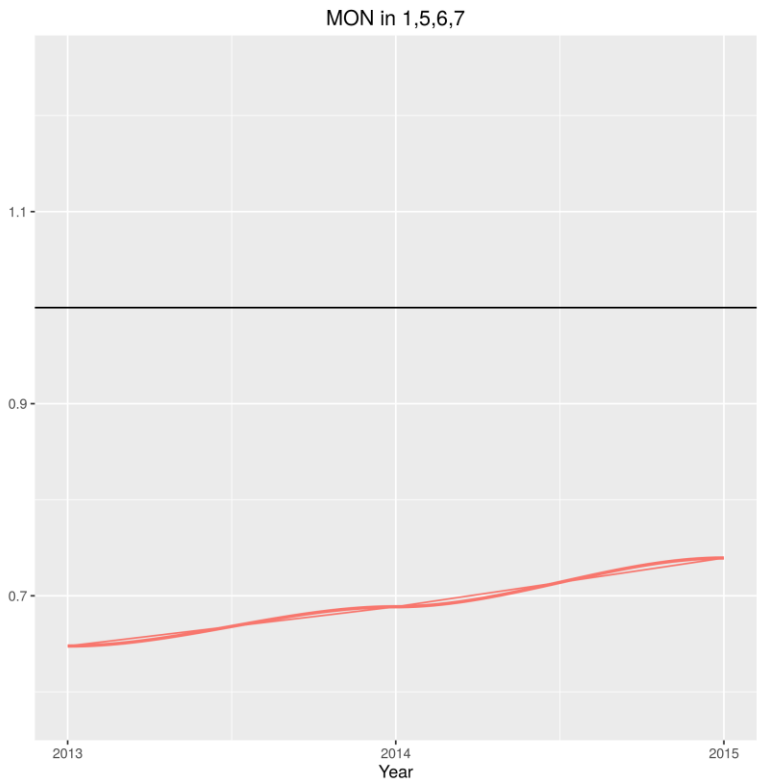


Figure 6.5.2.8. Anglerfish in GSA 1, 5, 6 and 7. Length-based indicator for anglerfish using the catch length composition for 2013, 2014, 2015

The overall perception from length-based indicators is that the stock is over fished at levels well above MSY level. Such perception supports the result obtained with VIT VPA for the same years. However, it must be taken into account that these indicators may not be as useful as for other species due to the bigger-deeper trend of L. piscatorius, which seems to result in an important part of the adult population deeper than 800 m, out of the limit of the bottom trawl fishery used in the length analysis (see bathymetric distribution paragraph in section 6.5.1.4).

Reference points for anglerfish in GSAs 1, 5, 6 AND 7

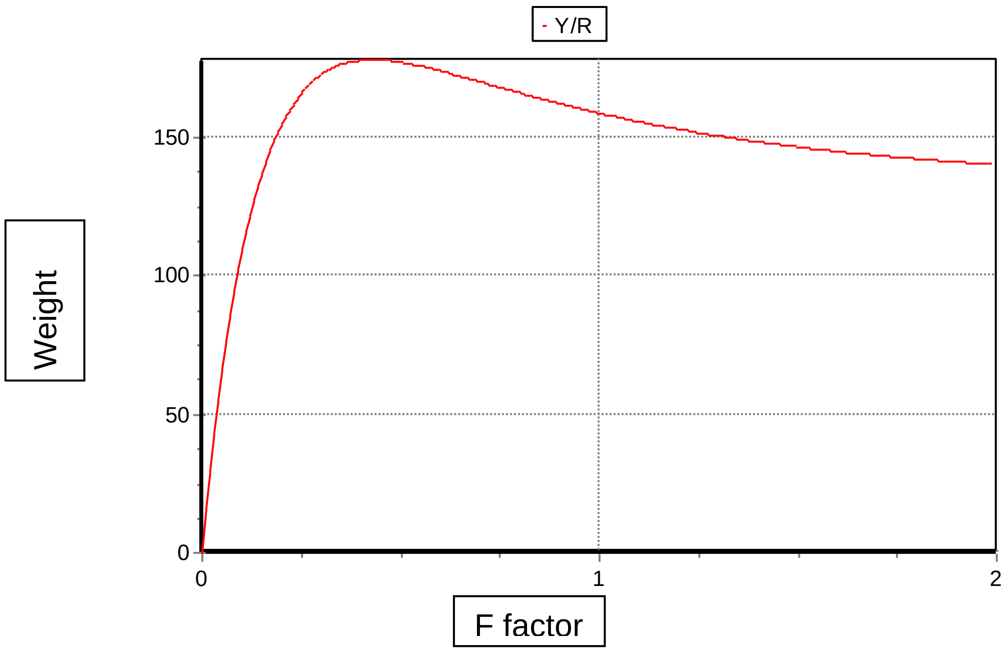


Figure 6.5.2.2.7 Anglerfish in GSAs 1,5,6 and 7. Results of the Y/R analysis for Monk fish (*Lophius piscatorius*).

6.5.3 REFERENCE POINT

F0.1 is estimated with only small variation, (0.18 to 27). In all the cases, the current levels of F are much higher than the rates corresponding to the reference value F0.1 for each year, and on average F is 3.3 times F0.1, which indicates that *L. piscatorius* is overfished, due to growth overfishing.

Table 6.5.3.3.1 Anglerfish in GSAs 1,5,6 and 7. Summary results of the reference points for Monk fish (*Lophius piscatorius*).

Year	Fcurr	Approx Abs F0.1	Estimated F/F0.1
2013	1	0.27	3.70
2014	0.70	0.23	3.03
2015	0.45	0.18	2.56
Average	0.72	0.22	3.27

The stock decreased in the number of recruits (R) from 2013 to 2015. Biomass (B) and Spawning stock biomass (SSB) showed an increasing trend in the years analyzed. The fishing mortality decreased from 2013 to 2015. Overall these changes are not considered to be significant, as the analysis is carried out for each year independently, so trends are not well evaluated. EWG 16-17 is unable to fully evaluate the state of the spawning stock due to the absence of proposed or agreed management reference points. However, the evaluation of F and the length indicator evaluation strongly support the conclusion that current F is substantially higher than F0.1.

Survey indices showed stability throughout the time period analyzed. No trends were detected either for the abundance and biomass or for the evolution of the immature and mature abundances in relation to the initial reference period of the surveys. Moreover, it seems that during the last years the population is increasing their abundance and mean individual weight southwards. Overall, it must be taken into account that there are no data on deeper bottoms than 800 m where according to our results it seems is where the fraction of the population that includes the biggest spawner habitat.
The EWG 16-17 are unable to propose a biomass reference point from the three year VPA results. A longer time series is needed, which would allow a more precise determination of the trends of the stocks analyzed. However based on the estimate of F0.1, EWG 16-17 recommends that fishing effort should be reduced until the fishing mortality is below F0.1 or the STECF proxy level of F_{MSY}, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations.

6.5.4 SHORT TERM FORECAST

There are no short term forecasts based on the results of the VIT method.

6.5.5 QUALITY AND PROPOSALS FOR FUTURE ASSESSMENTS

There is a fraction of the landings in ports of Spain, at the north of the GSA 6, that come from catches made in the GSA 7. The time series of the bottom trawl fleet landings of L. piscatorius, which account for a mean 95% of the total landings across GSAs, were the only ones with the minimum quality in the length distribution and landing data allowing the analyses. There is a high variability in the three years available of landings data of gill nets, trammel nets, and long lines for both Spanish and French fleets. There are also some inconsistencies such as that in 2013 the landings in GSA 7 for the Spanish fleet showed the minimum of the whole series coinciding with the maximum from that GSA for the French fleet. Moreover, the length distributions for the GSA 7 do not have enough quality (probably due to they come from few individuals some years) if considered separately by country, and by year

To achieve a time series of landings data and length frequencies long enough to perform analytical models able to follow the complete evolution of the cohorts. Also there is a need for improved information on local growth rates to allow evaluations to be based more on local biology.

6.6 STRIPED RED MULLET IN GSA 9

6.6.1 DATA GATHERING OF STRIPED RED MULLET IN GSA 9

6.6.1.1 Stock Identity and Biology

Striped red mullet (*Mullus surmuletus*) is an important demersal target species of Ligurian and North Tyrrhenin Sea (GSA 9). Generally, this species is mostly found on the continental shelf up to depths of 200 m; the highest concentration of individuals is usually found in the 0-150 m depth range. Striped red mullet usually inhabits mixed sediment as well as rocky and detritic bottoms, with a preference for patchy habitats made up of sand, rocks, coralligenous benthic communities. In coastal areas the species is often found in *Posidonia oceanica* seagrass meadows.

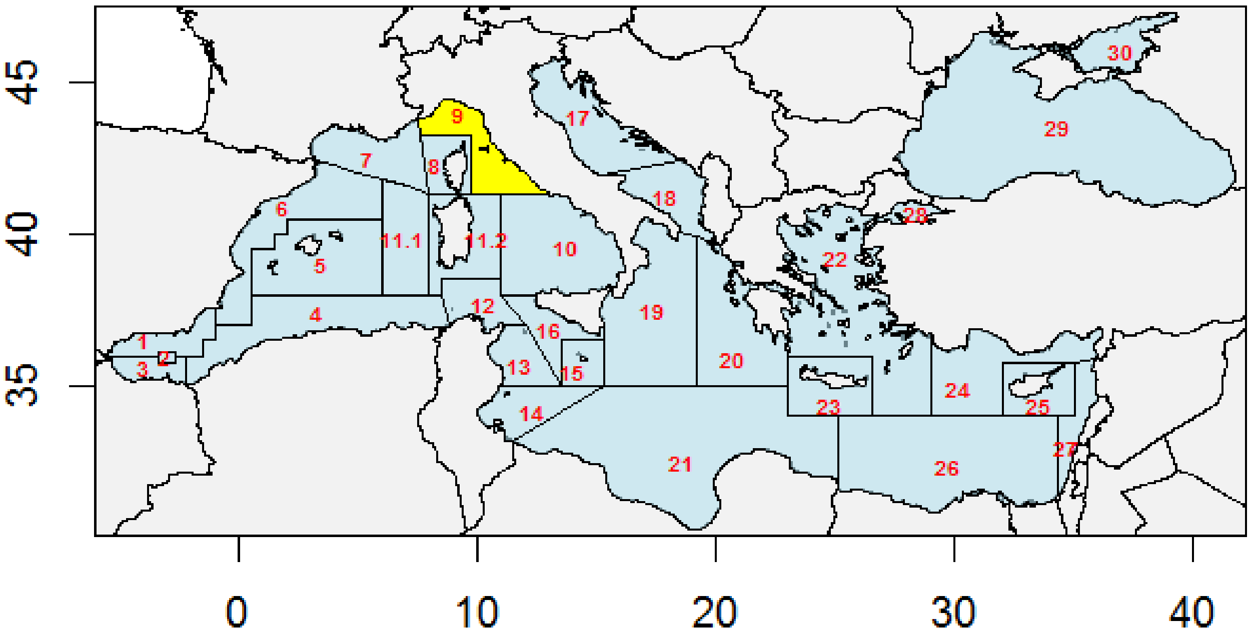


Figure 6.6.1.1.1. Geographical location of GSA 9.

This stock was assumed to be confined within the boundary of GSA 9 (Figure 6.6.1.1.1.).

Striped red mullet growth parameters (L_∞, K, t_0) for this area were provided throughout the DCF data. The growth parameters obtained for combined sexes by reading the otoliths were:

L_∞=32 cm K=0.43 year^{-1} t_0=-0.7

Parameters of an overall length-weight relationship were also provided for both sexes joined and allometrical coefficient (b) and constant (a) were 3.142 and 0.009, respectively.

Spawning season of striped red mullet starts by the beginning of the spring (April) and last till the end of the summer (September) with peak in May. According to the DCF data on maturity, it seems that almost all striped red mullet individuals are matured by the age of 2.

6.6.1.2 Catch data

Total catch of the species from 2006 has been in general decreasing trend although in the last 4 years has shown increasing trend. In the 2015 total catch has been at the level of 260.4 tonnes (Figure 6.6.1.2.1.).

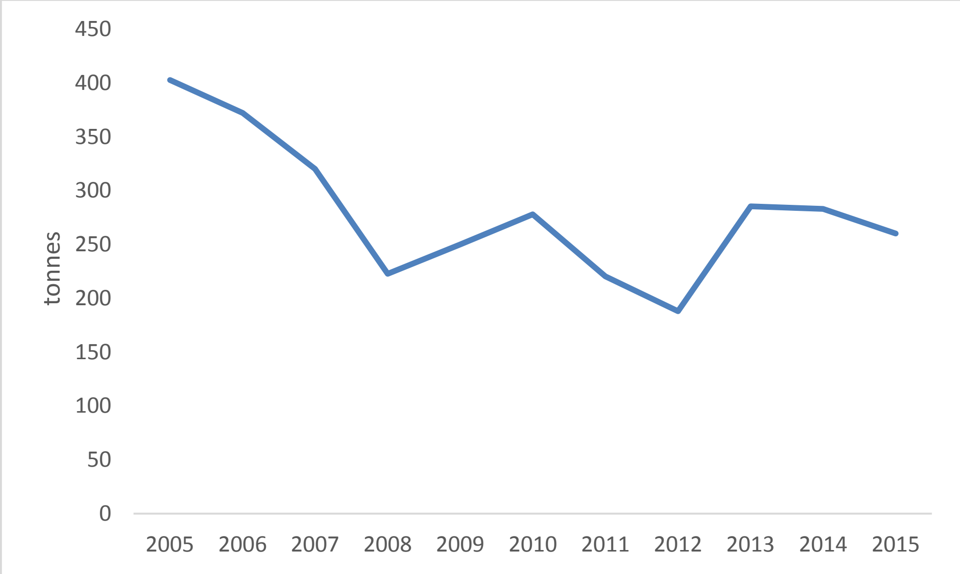


Figure 6.6.1.2.1. Striped red mullet in GSA 9. Fluctuation of striped red mullet total landings obtained in GSA 9 from 2005 till 2015.

The stock is caught with different fishing strategies: bottom trawling operates on soft bottoms while the use of gillnets and trammel nets occur in areas close to the coast most of the times on hard bottoms. Nevertheless, it is obvious that in the last few years (2012-2015) OTB has become the most active fishing gear targeting this species in the area (Figure 6.6.1.2.2).

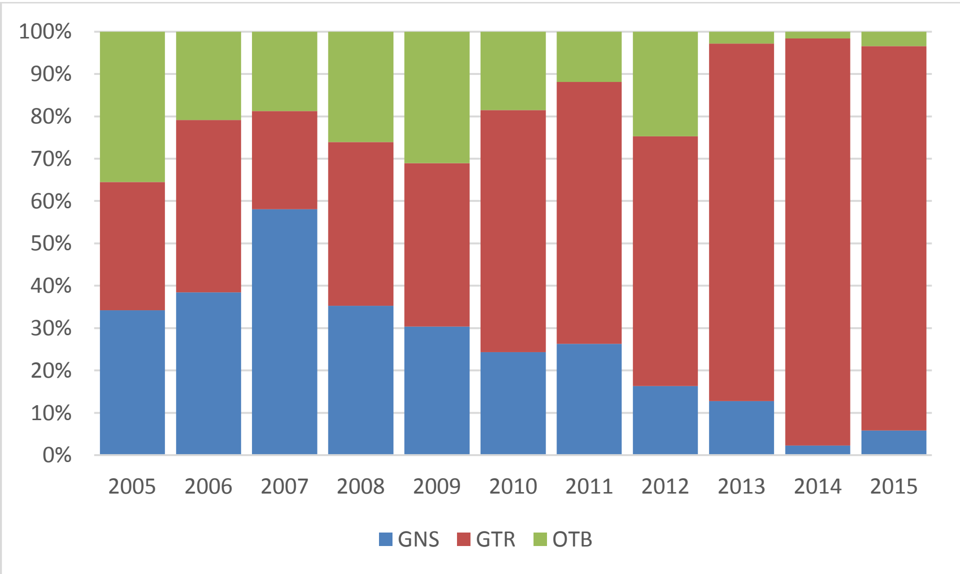


Figure 6.6.1.2.2. Striped red mullet in GSA 9. Proportion of catches obtained by trammel nets (GTR), bottom otter trawlers (OTB) and gillnets (GNS), 2005-2015.

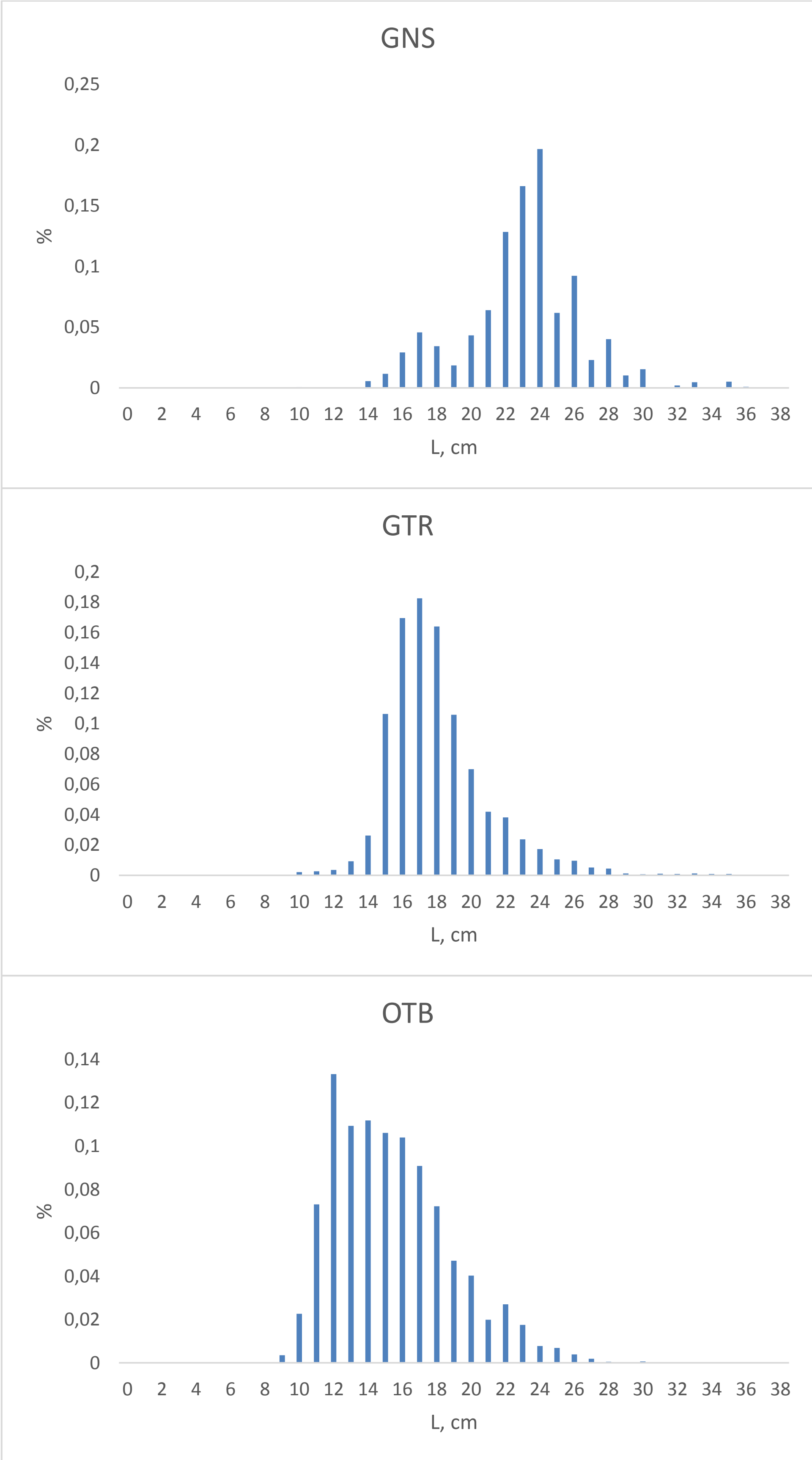


Figure 6.6.1.2.3. Striped red mullet in GSA 9. Proportion of lengths in catches obtained by gillnets (GNS), trammel nets (GTR) and bottom otter trawlers (OTB), 2005-2015.

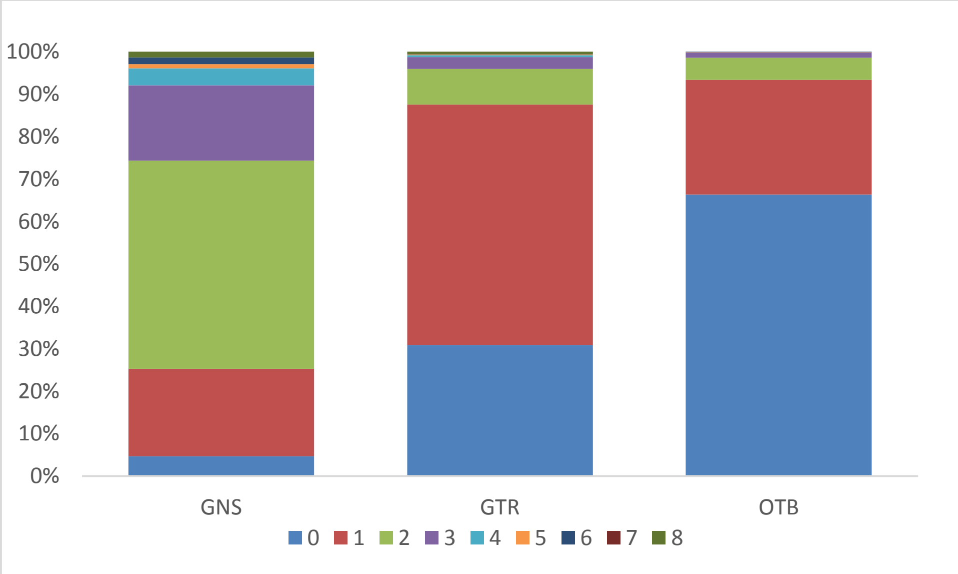


Figure 6.6.1.2.4. Striped red mullet in GSA 9. Proportion of ages in catches obtained by gillnets (GNS), trammel nets (GTR) and bottom otter trawlers (OTB), 2005-2015

Mean length varied over the years (Figure 6.6.1.2.4) with peak in 2011 at 20.36 cm and in 2015 reaching 17.02 cm as one of the lowest in the series.

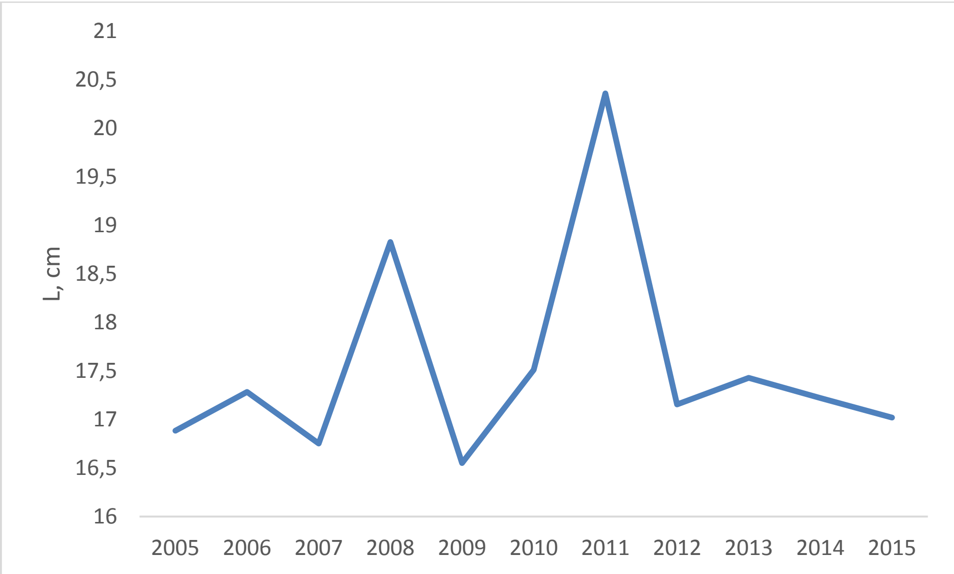


Figure 6.6.1.2.5. Striped red mullet in GSA 9. Fluctuation of striped red mullet mean length in catches from GSA 9 from 2005 till 2015

Age frequency distribution is given on a Figure 6.6.1.2.6. According to otolith readings eight age classes (0-8) were determined in analysed stock, while the most abundant ages in the catches were 0 and 1 along the whole period of investigation.

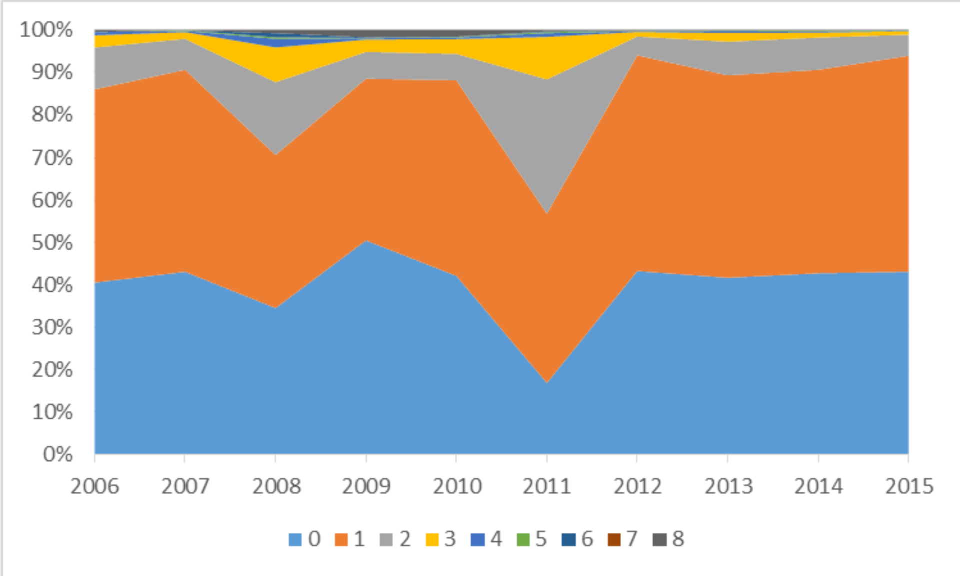


Figure 6.6.1.2.6. Striped red mullet in GSA 9. Age frequency distribution of striped red mullet caught within GSA 09, 2006-2015

Discard data were reported only for OTB in 2013 in total of 10 t, and is considered negligible

6.6.1.3 Fishing effort data

Striped red mullet in the area GSA 9 is mainly fished with GTR GNS and OTB. Nominal effort values alternations for those fishing gears are given in Figure 6.6.1.3.1.

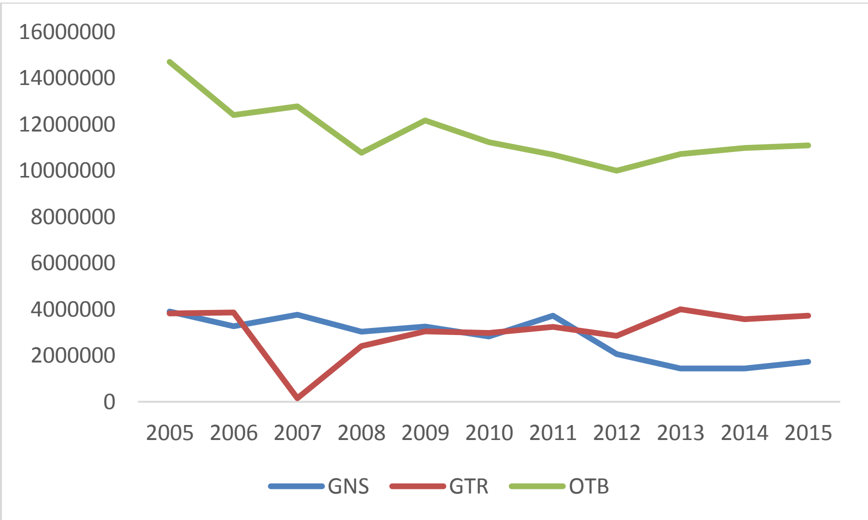


Figure 6.6.1.3.1. Striped red mullet in GSA 9. Oscillation of nominal effort values for trammel nets (GTR), gill nets (GNS) and bottom otter trawlers (OTB) obtained from 2005 till 2015 in GSA 9.

6.6.1.4 Survey Indices of abundance and biomass by year and size/age

Since 1994, MEDITS trawl surveys has been regularly carried out each year during the spring season. In the current assessment only data from 2006 onwards were used since it was also the catches data available. Striped red mullet density showed large fluctuations and very high peak was detected in 2012. (Figure 6.6.1.4.1.).

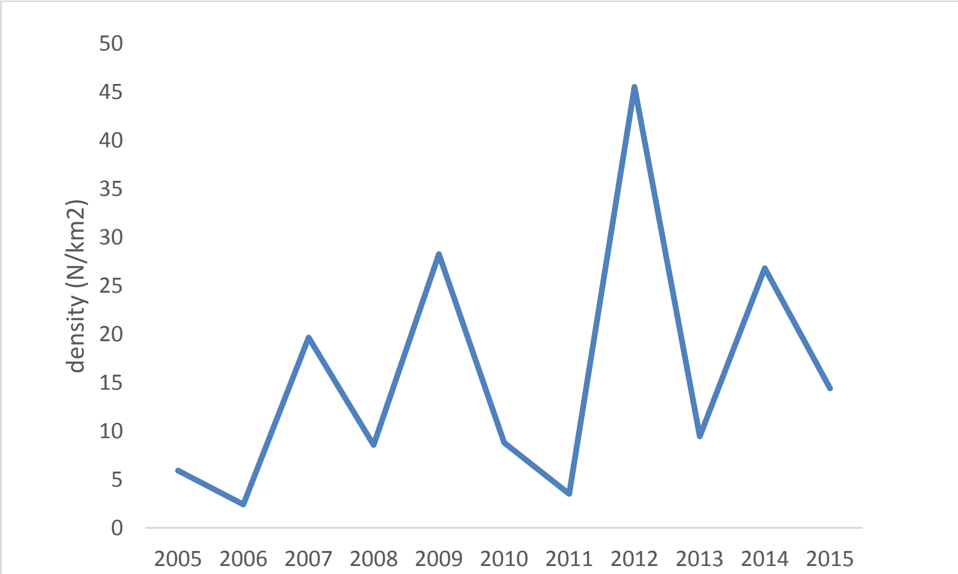


Figure 6.6.1.4.1. Striped red mullet in GSA 9. Striped red mullet density fluctuation obtained by the scientific survey MEDITS from 2005 till 2015

Length frequencies obtained each year during the MEDITS surveys were converted to ages by the von Bertalanffy growth parameters for this stock and given in Figure 6.6.1.4.2.

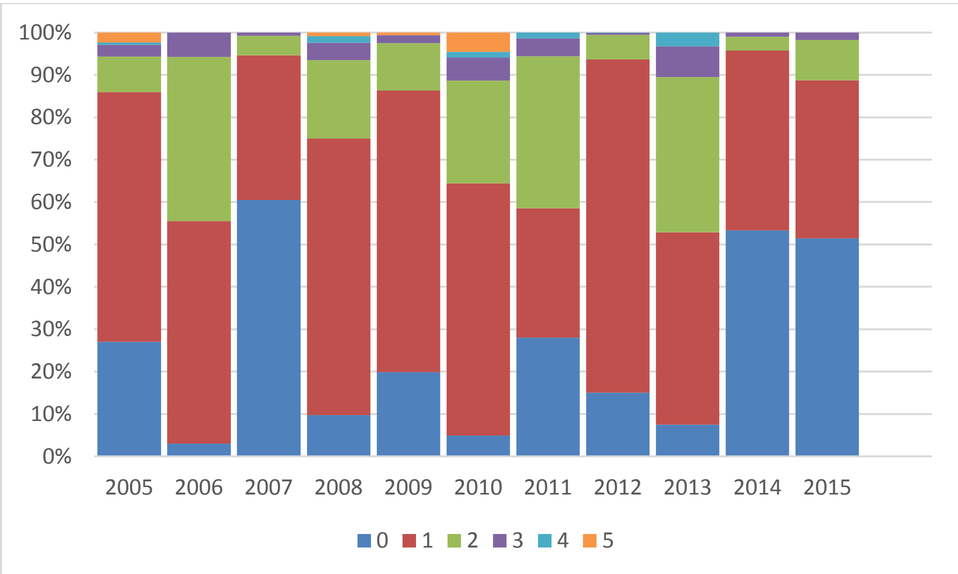


Figure 6.6.1.4.2. Striped red mullet in GSA 9. Striped red mullet age frequency distribution observed during MEDITS surveys from 2005 to 2015.

6.6.2 STOCK ASSESSMENT ON STRIPED RED MULLET IN GSA 9

Method XSA

The major assumption of the method is the flat selectivity for the oldest ages (selectivity as classical ogive). The method performs a tuning by survey index by age. The method was applied using the age data obtained from the DCF data and, as tuning indices, MEDITS survey data sliced with von Bertalanffy growth parameters from DCF report.

XSA uses catch-at-age, mean weight at age, landing, proportion of mature individuals by age, natural mortality by age and mean weight at age in stock to perform the analysis, which is tuned by survey data (MEDITS) by age. Catch-at-age and tuning data are presented in tables 6.6.2.1 - 6.6.2.4. Plus group 4 was used due to the inconsistences in cohorts in the age structure. F bar was set from 0 to 3 due to the amounts of those ages in the catches. Fishing and natural mortality before spawning were set to be 0.

INPUT DATA

Table 6.6.2.1. Striped red mullet in GSA 9. Catch at age from DCF data

age	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
0	1919.84	1766.39	708.94	1543.92	1345.44	291.27	1081.06	1483.82	1566.14	1501.93
1	2151.19	1948.87	738.58	1164.64	1469.98	686.16	1267.90	1695.09	1753.52	1770.46
2	466.89	298.84	351.02	193.30	198.43	543.42	110.34	281.45	278.37	173.35
3	135.50	65.87	168.21	88.49	111.39	172.09	27.36	72.58	43.10	28.52
4	58.46	18.55	83.70	68.49	67.49	27.75	10.28	24.68	21.14	8.47

Table 6.6.2.2. Striped red mullet in GSA 9. Weigth at age from DCF data

age	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
0	0.038	0.044	0.046	0.043	0.044	0.046	0.048	0.045	0.045	0.043
1	0.084	0.088	0.088	0.089	0.087	0.103	0.085	0.090	0.097	0.088
2	0.160	0.154	0.166	0.159	0.165	0.166	0.163	0.168	0.167	0.171
3	0.256	0.241	0.236	0.235	0.234	0.237	0.236	0.233	0.238	0.241
4	0.361	0.321	0.351	0.357	0.357	0.343	0.346	0.346	0.347	0.368

Table 6.6.2.3. Striped red mullet in GSA 9. Maturity at age from DCF data.

age	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
0	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065
1	0.655	0.655	0.655	0.655	0.655	0.655	0.655	0.655	0.655	0.655
2	1	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1	1	1

4	1	1	1	1	1	1	1	1	1	1

Table 6.6.2.4. Striped red mullet in GSA 9. Density at age from MEDITS DCF data

age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2
0	1.596	0.073	11.896	0.837	5.606	0.409	0.979	6.831	0.704	13.761	7
1	3.483	1.279	6.702	5.590	18.803	4.980	1.067	35.775	4.283	10.947	5
2	0.495	0.942	0.913	1.586	3.159	2.029	1.256	2.662	3.457	0.836	1
3	0.163	0.141	0.149	0.350	0.537	0.453	0.148	0.200	0.683	0.266	0
4	0.173	0	0	0.212	0.167	0.496	0.049	0.042	0.307	0	

SCENARIOS TESTED

After trying different scenarios of r_{age} and g_{age}, the r_{age}=1 and g_{age}=3 have been chosen because the resulted in the lowest residuals (Figure 6.6.2.1.).

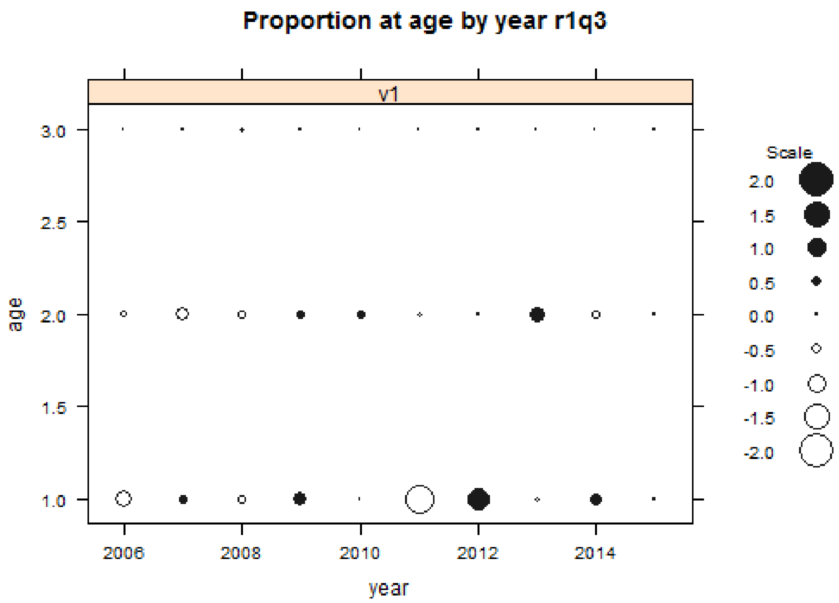
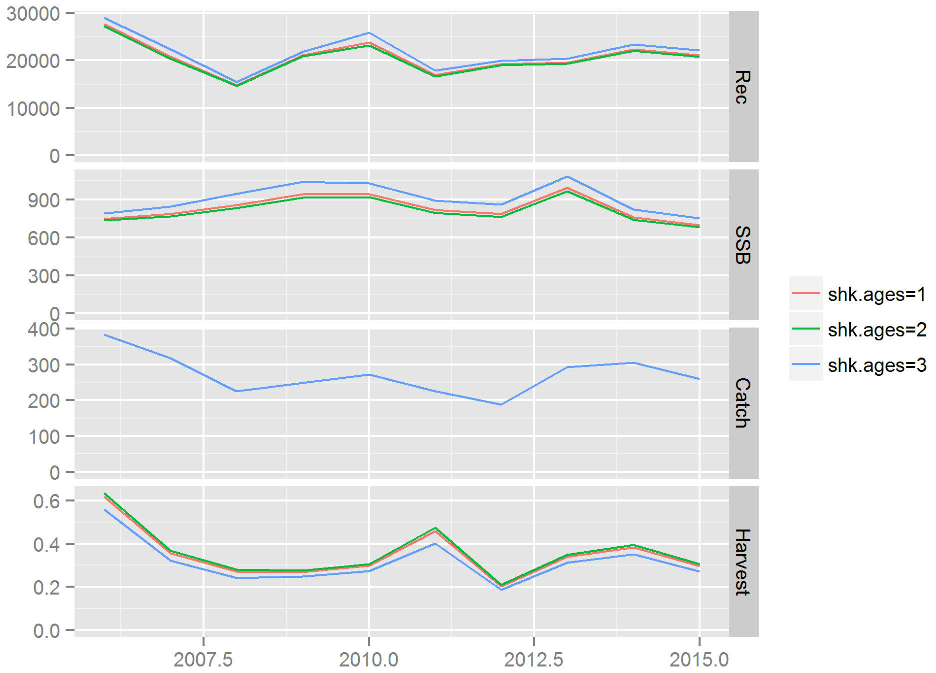


Figure 6.6.2.1. Striped red mullet in GSA 9. XSA; residuals of the best run for rage=1 and gage=3

After trying different scenarios on the shrinkage of years it was decided that age shrinkage sh.=1 has the lowest residuals (Figure 6.6.2.2.)., lowest F shrinkage (Figure 6.6.2.3) and best retrospective performance over the last three years (Figure 6.6.2.4.).



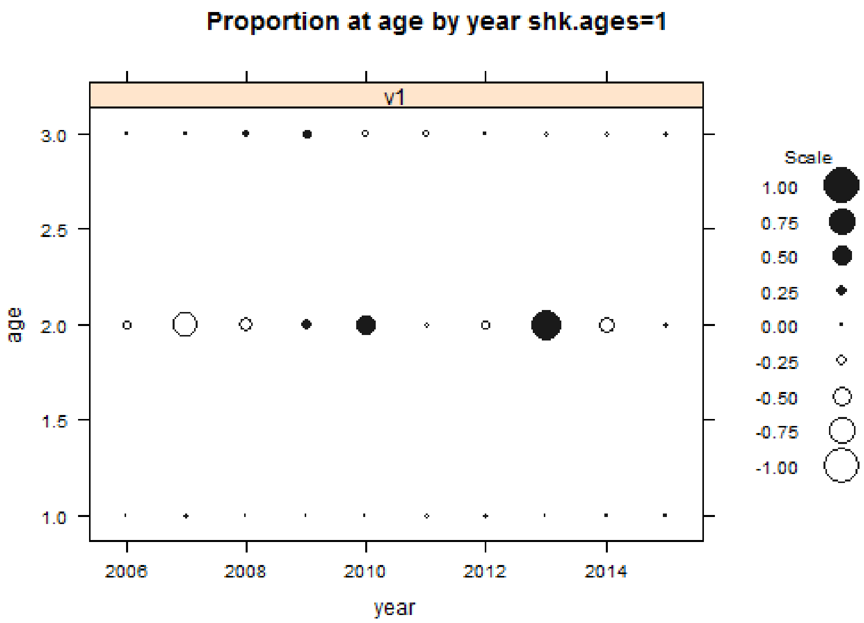
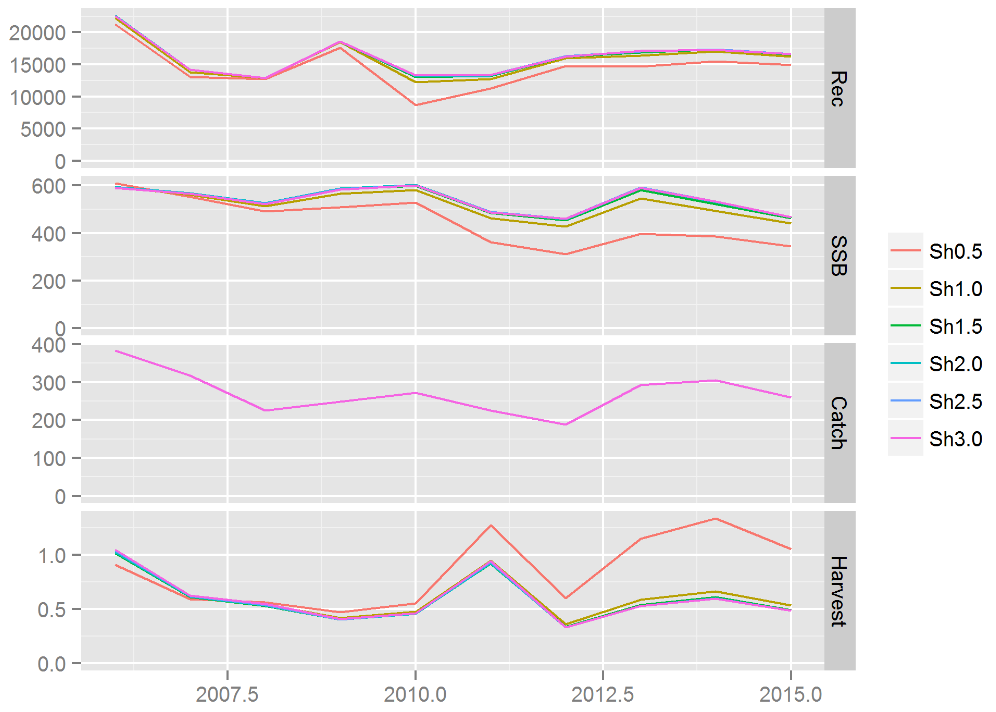


Figure 6.6.2.2. Striped red mullet in GSA 9. XSA. Residuals of the best run for shrk.age=1.

Different scenarios were also tested for fse, and fse=1.5 had the best residuals and diagnostic so that was the one chosen as final run (Figure 6.6.2.3).



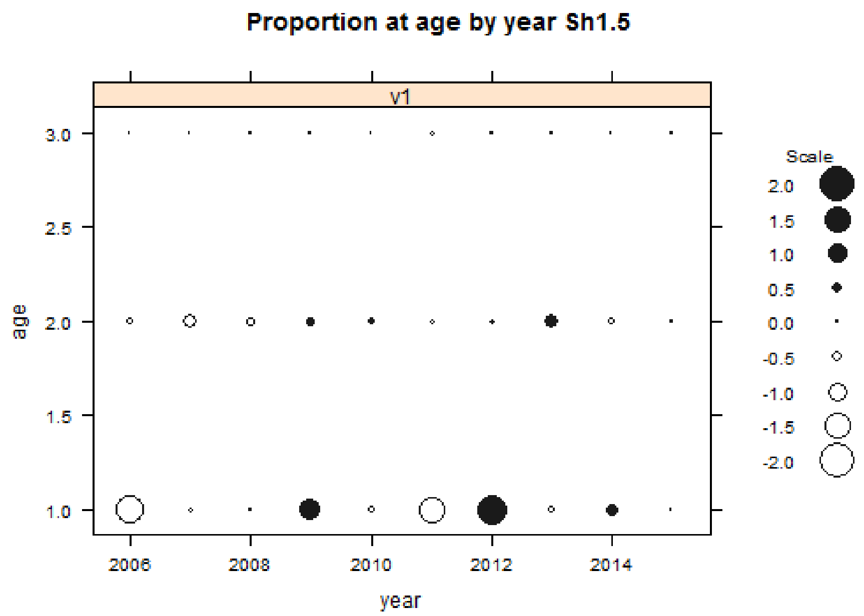


Figure 6.6.2.3. Striped red mullet in GSA 9. XSA. Residuals of the best run for different shrinkages and the best fse=1.5

The last run was subjected to the retrospective and the results for 3 years of retro are shown in the Figure 6.6.2.4.

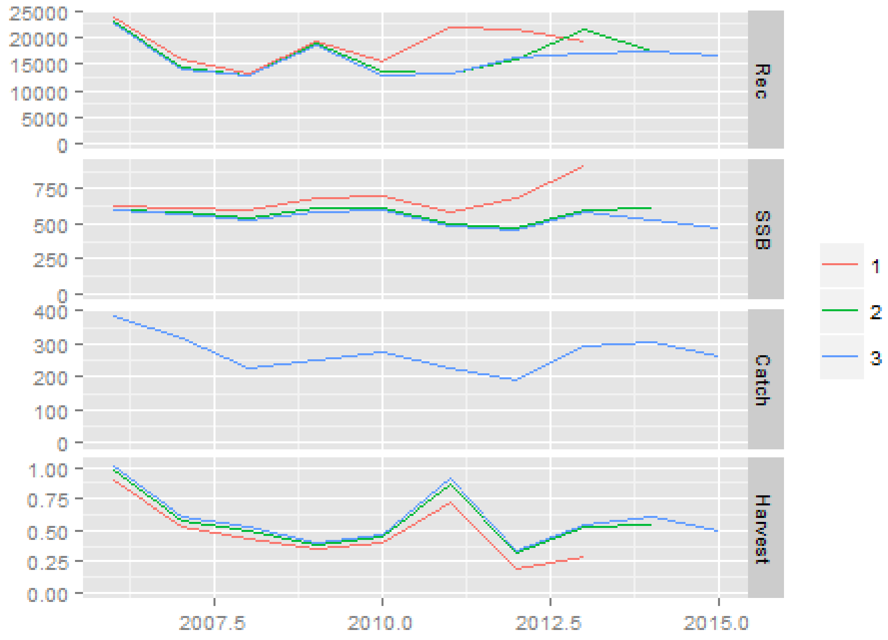


Figure 6.6.2.4. Striped red mullet in GSA 9. XSA. Retrospective for the final run.

Final run: FLXSA.control (x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=1.5, rage=1, qage=3, shk.n=TRUE, shk.f=TRUE, shk.yrs=3, shk.ages=1, window=100, tsrange=20, tspower=3, vpa=FALSE)

RESULTS

Results arriving from the last run are shown in the Table 6.6.2.5- Table 6.6.2.8, and Figures 6.6.2.5. and 6.6.2.6.

SSB has shown very slight downward trend as the maximum value was observed in 2006 (594.83 t). Value of 463.48 t was reached in 2015 (Figure 16, Table 7). Recruits have shown stable trend during the period from 2006 to 2015 with maximum in 2006 with 22568 and current at 16625 tonnes (Figure 16, Table 8). F bar (0-3) has been showing general negative trend with maximum reaching 0.91 in 2011, and current value of 0.49, nevertheless, it is below F0.1 value (0.52) (Figure 15 and 16, Table 5). The values for 2011 may be the result of poorer data for that year, but this does not appear to influence the general conclusions.

Table 6.6.2.5. Striped red mullet in GSA 9. XSA results. Fishing mortality by age.

age	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
0	0.161	0.246	0.101	0.157	0.199	0.039	0.124	0.167	0.172	0.173
1	0.932	0.788	0.444	0.767	0.688	0.423	0.768	1.009	1.074	1.053

2	1.360	0.594	0.601	0.365	0.531	1.453	0.195	0.771	0.915	0.510
3	1.608	0.814	0.973	0.333	0.425	1.760	0.255	0.215	0.278	0.234
4	1.608	0.814	0.973	0.333	0.425	1.760	0.255	0.215	0.278	0.234

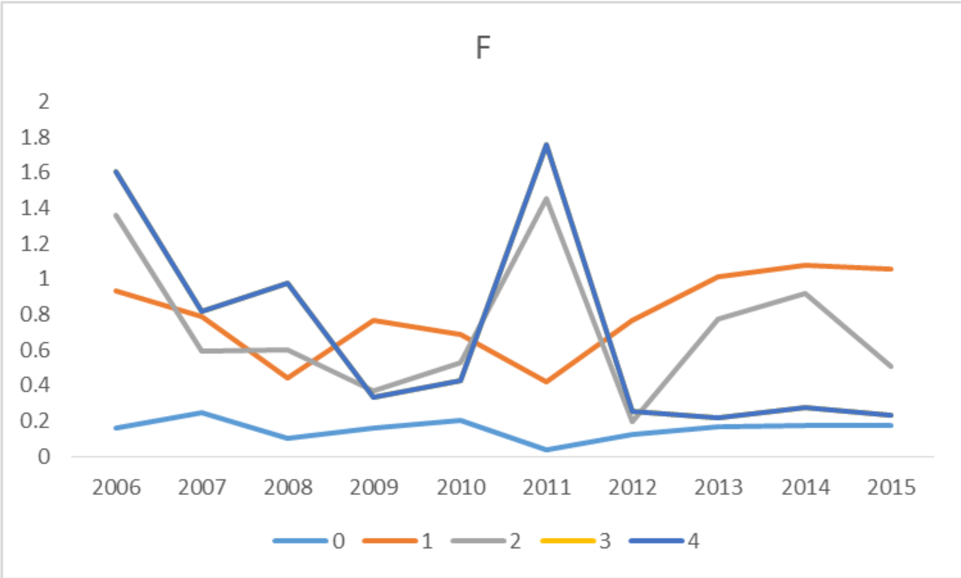


Figure 6.6.2.5. Striped red mullet in GSA 9. XSA results. Fishing mortality by age.

Table 6.6.2.6. Striped red mullet in GSA 9. XSA results. Stock age in numbers.

age	2006	2007	2008	2009	2010	2011	2012	2013	2014	2
0	22557.11	14158.40	12910.15	18569.11	13033.11	13203.64	16213.76	16893.45	17341.10	16569
1	6214.59	6261.00	3609.23	3806.01	5174.93	3482.61	4140.28	4671.03	4662.70	4761
2	751.28	798.44	929.12	755.41	576.27	848.38	744.05	626.32	555.46	519
3	193.04	134.69	308.13	355.83	366.29	236.82	138.58	427.69	202.39	155
4	80.35	37.17	149.76	272.67	219.27	36.73	51.65	144.36	98.40	45

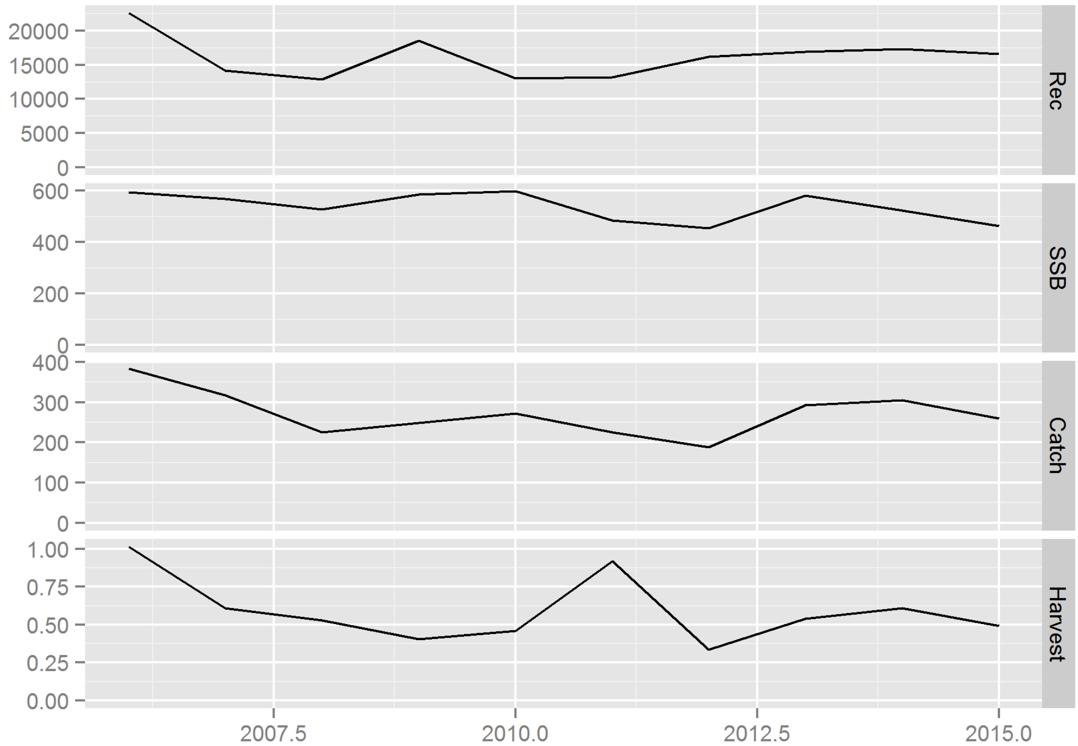


Figure 6.6.2.6. Striped red mullet in GSA 9. XSA results.

Table 6.6.2.7. Striped red mullet in GSA 9. XSA results. Recruitment. SSB. Catch. F.

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Recruits	22568	14225	12871	18556	13271	13352	16264	17069	17318	16625
Fbar	1.015	0.611	0.530	0.406	0.461	0.919	0.336	0.541	0.610	0.492
SSB	594.83	568.51	526.32	585.13	598.77	483.86	453.29	580.34	522.63	463.48
Catch	383.10	316.96	225.04	248.61	272.30	224.49	187.73	292.19	304.78	259.94

Method 2. Length-based analysis

Length-based methods were used for deriving some indicators explored in WKLIFE IV. (ICES, 2015). They allow classifying the stocks according to conservation/sustainability, yield optimization and MSY considerations. Analysis required data on the stock catch/landings–length composition and life-history parameters as Linf.

The length-based indicators analysis was performed using the commercial landings in 2013to 2015 (discards considered negligible) and the following life-history parameters: Linf=32.0,.

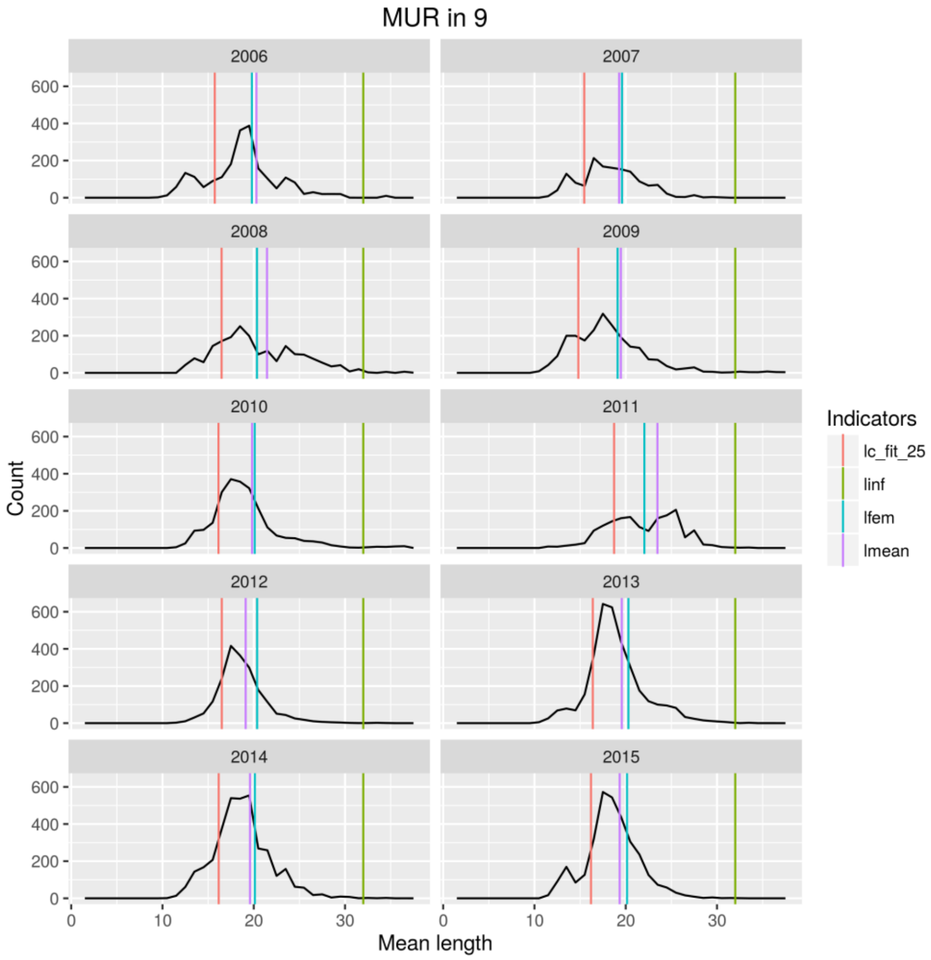


Figure 6.6.2.7. Striped Red Mullet in GSA 9. Length-based indicators and reference points for striped red mullet using the catch length composition for 2006, to 2015

Figure 6.6.2.8. Striped red mullet in GSA 9. Length-based indicator for striped red mullet using the catch length composition for 2006 to 2015

The overall perception from length-based indicators is that the stock is being fished close to the MSY level. Such perception supports the result obtained XSA assessment. The detail is slightly different, the XSA assessment suggests a slight reduction in F over the period, the length indicators a slight rise exploitation rate. As the XSA assessment incorporates more detail in the data this is taken as the primary source for advice.

6.6.3 REFERENCE POINTS

The time series of SSB and R values is not sufficient to allow evaluation of S-R elements of MSY, so the WG has applied the STECF recommended method of F0.1. The $F_{0.1}$ value estimated on the basis of the XSA was 0.52 by FLBRP package (FLR library).

6.6.4 SHORT TERM FORECAST

Table 6.6.4.9. Striped red mullet in GSA 9. Short term prediction.

Rationale	F factor	Fbar	Catch 2015	Catch 2016	Catch 2017	Catch 2018	SSB 2017	SSB 2018	Change SSB 2017-2018(%)	Change Catch 2015-2017(%)
ZERO CATCH	0.000	0.000	259.938	281.345	0.000	0.000	556.513	853.652	53.393	-100.000
F 0.1	1.072	0.518	259.938	281.345	312.724	312.894	556.513	567.885	2.043	20.307
STATUS QUO	1.000	0.483	259.938	281.345	296.730	302.052	556.513	581.366	4.466	14.154
Different scenarios	0.100	0.048	259.938	281.345	37.574	49.769	556.513	817.139	46.832	-85.545
	0.200	0.097	259.938	281.345	73.034	93.507	556.513	783.164	40.727	-71.903
	0.300	0.145	259.938	281.345	106.533	132.005	556.513	751.519	35.041	-59.016
	0.400	0.193	259.938	281.345	138.214	165.947	556.513	722.019	29.740	-46.828
	0.500	0.242	259.938	281.345	168.206	195.925	556.513	694.491	24.793	-35.290
	0.600	0.290	259.938	281.345	196.630	222.451	556.513	668.777	20.173	-24.355
	0.700	0.338	259.938	281.345	223.596	245.968	556.513	644.735	15.853	-13.981
	0.800	0.387	259.938	281.345	249.207	266.860	556.513	622.231	11.809	-4.128
	0.900	0.435	259.938	281.345	273.556	285.459	556.513	601.145	8.020	5.239
	1.000	0.483	259.938	281.345	296.730	302.052	556.513	581.366	4.466	14.154
	1.100	0.531	259.938	281.345	318.809	316.891	556.513	562.792	1.128	22.648
	1.200	0.580	259.938	281.345	339.868	330.191	556.513	545.330	-2.009	30.750
	1.300	0.628	259.938	281.345	359.975	342.140	556.513	528.895	-4.963	38.485
	1.400	0.676	259.938	281.345	379.191	352.904	556.513	513.409	-7.745	45.878
	1.500	0.725	259.938	281.345	397.577	362.623	556.513	498.798	-10.371	52.951
	1.600	0.773	259.938	281.345	415.186	371.422	556.513	484.998	-12.850	59.725
	1.700	0.821	259.938	281.345	432.067	379.409	556.513	471.949	-15.195	66.219
	1.800	0.870	259.938	281.345	448.266	386.677	556.513	459.593	-17.416	72.452
	1.900	0.918	259.938	281.345	463.827	393.310	556.513	447.881	-19.520	78.438
	2.000	0.966	259.938	281.345	478.789	399.378	556.513	436.765	-21.517	84.194

6.6.5 QUALITY AND PROPOSALS FOR FUTURE ASSESSMENTS

No comments

6.7 STRIPED RED MULLET IN GSA 11

6.7.1 DATA GATHERING OF STRIPED RED MULLET IN GSA 11

6.7.1.1 Stock Identity and Biology

Striped red mullet (*Mullus surmuletus*) is an important demersal target species of Sardinian coasts (GSA 11). Generally, this species is mostly found on the continental shelf up to depths of 200 m; the highest concentration of individuals is usually found in the 0-150 m depth range. Striped red mullet usually inhabits mixed sediment as well as rocky and detritic bottoms, with a preference for patchy habitats made up of sand, rocks, coralligenous benthic communities. In coastal areas the species is often found in *Posidonia oceanica* seagrass meadows.

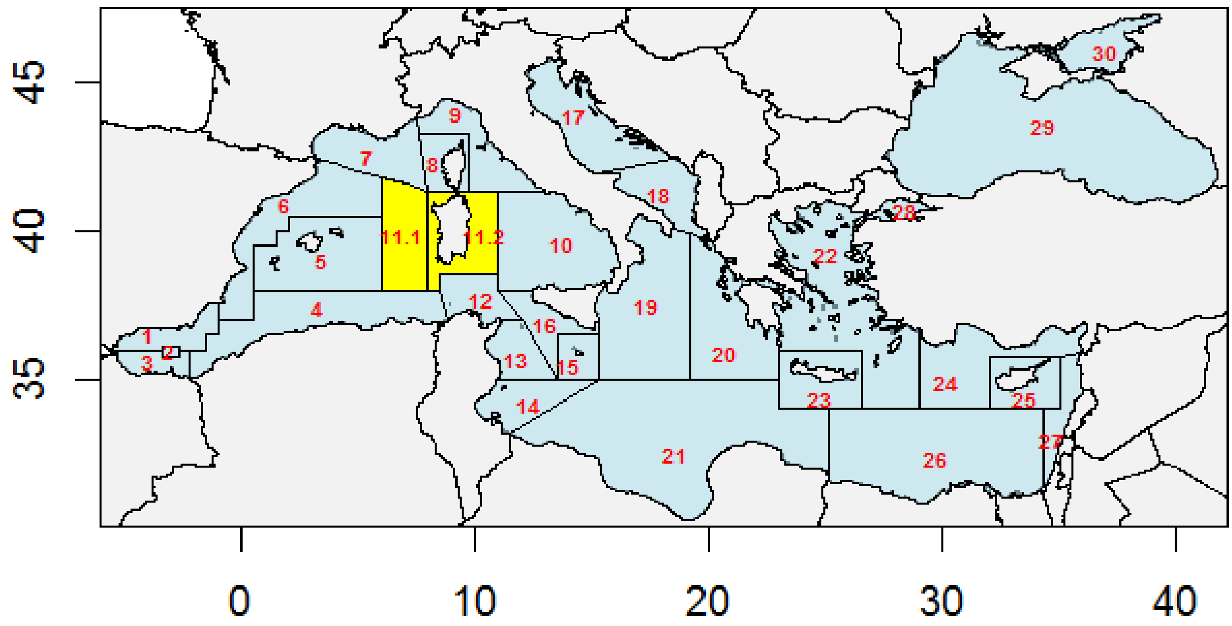


Figure 6.7.1.1. Geographical location of GSA 11.

Due to a lack of information about the structure of the striped red mullet population in the eastern Mediterranean, this stock was assumed to be confined within the boundary of GSA 11 (Figure 6.7.1.1.).

Striped red mullet growth parameters (L_{inf}, K, t_0) for this area were provided throughout the DCF data. The growth parameters were obtained for combined sexes by reading the otoliths and there are:

L_{inf}=35.87 cm K=0.28 year-1 t_0=-1.07

Parameters of an overall length-weight relationship were also provided and allometrical coefficient (b) and constant (a) were 3.2217 and 0.0063, respectively.

Spawning season of striped red mullet starts by the beginning of the spring (April) and last till the end of the summer (September). According to the DCF data Age/Length at maturity almost all striped red mullet individuals are matured by the age of 2.

6.7.1.2 Catch data

Although, striped red mullet in GSA 11 is fished by four fishing gears (OTB, GTR, GNS, LLS) majority of its catches were obtained by trammel nets and bottom otter trawlers during 2005-2015 (Figure 6.7.1.2.1.).

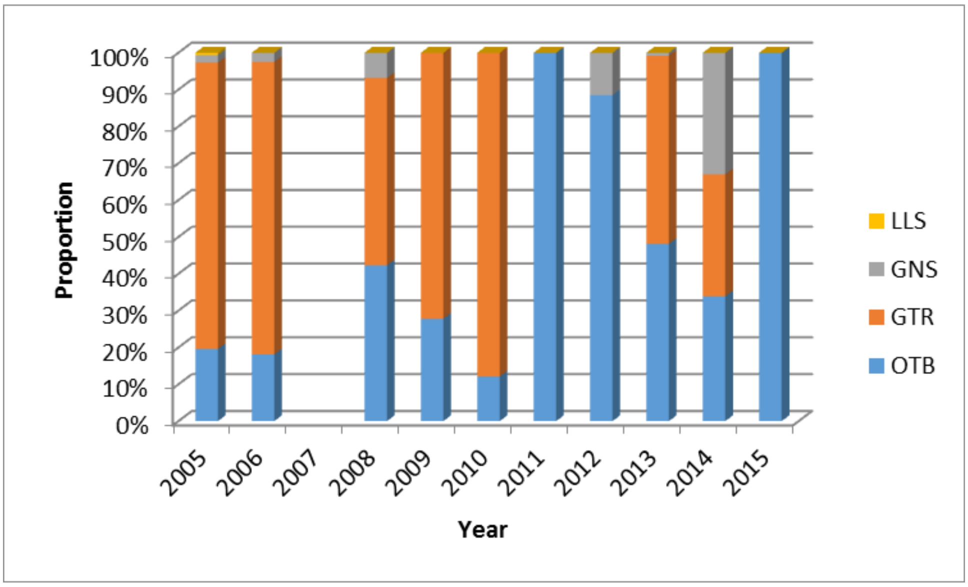


Figure 6.7.1.2.1. Striped red mullet in GSA 11. Proportion of catches obtained by trammel nets (GTR), bottom otter trawlers (OTB), gillnets (GNS) and longlines (LLS), 2005-2015. Information on 2007 is not available.

During observed period (2005-2015) landings of striped red mullet varied showed a considerable downward trend (Figure 6.7.1.2.2.). The highest landings were obtained in 2006 (567 t), while the lowest landed value, except 2007 when no landings of this species was reported, was 110 t in 2014, overall landings in the last two years are now 1/5th landings 9 years earlier .

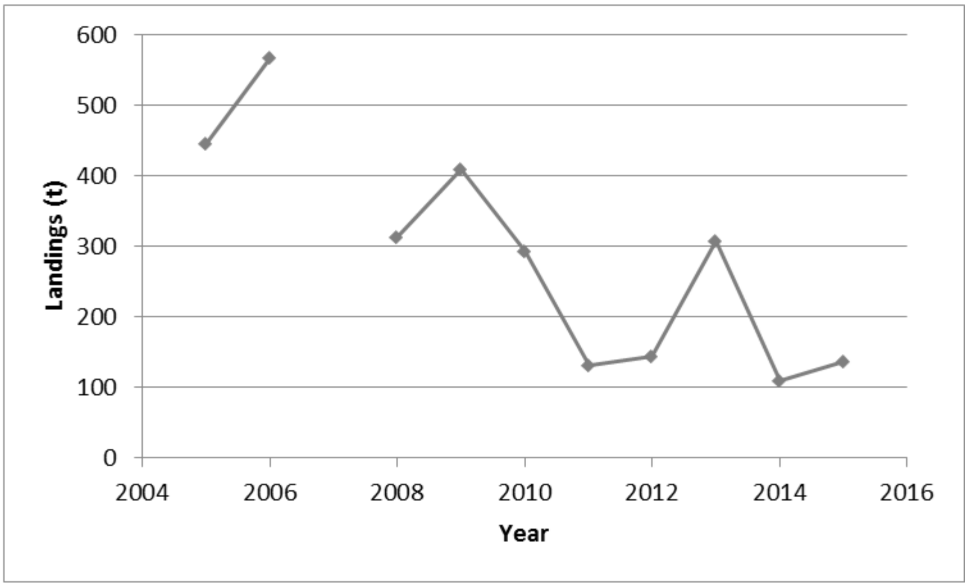
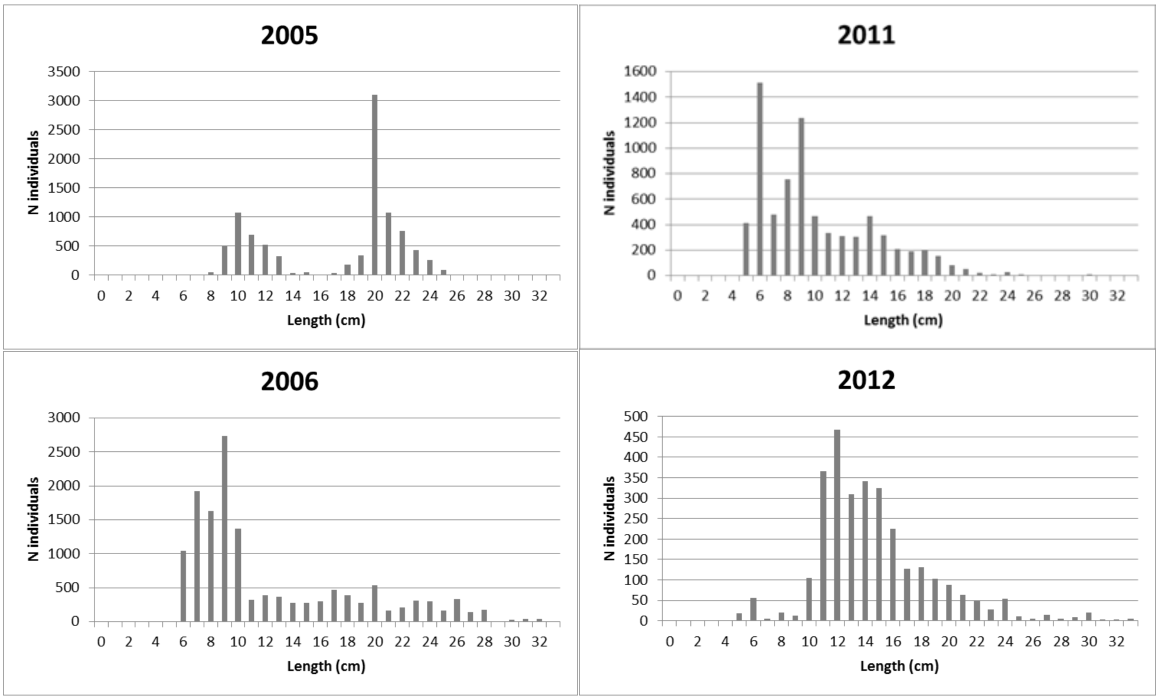


Figure 6.7.1.2.2. Striped red mullet in GSA 11. Fluctuation of striped red mullet landings obtained in GSA 11 from 2005 till 2015

Length frequencies of total striped red mullet caught in GSA 11 are shown in Figure 6.7.1.2.3. Highest length range was observed in 2012 (5 – 32 cm), while the lowest were noted in 2005 (5 -25 cm) and 2015 (10-27 cm). Annual mean length of striped red mullet over the observed period did not show any trend (Figure 6.7.1.2.4.).



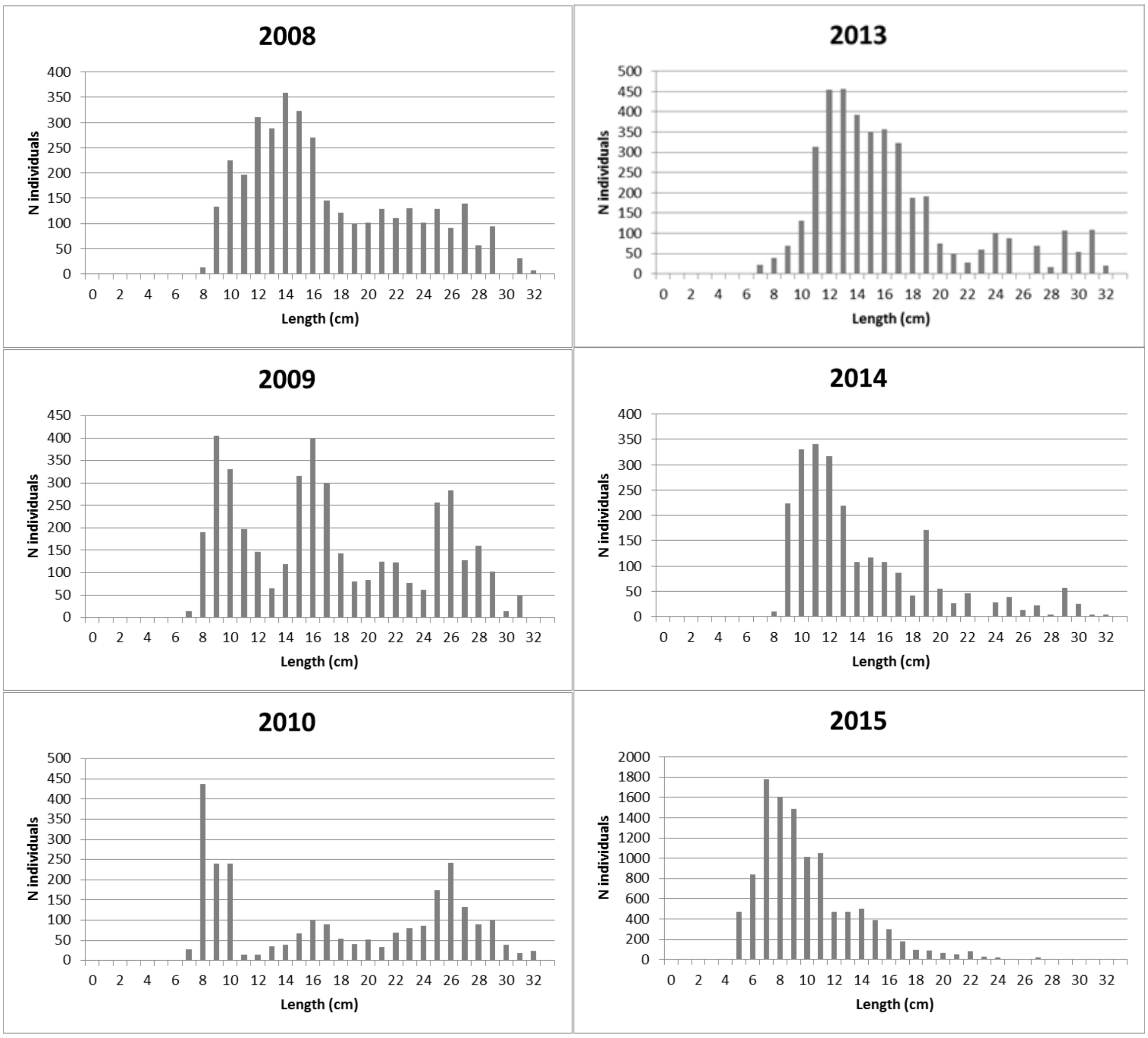


Figure 6.7.1.2.3. Striped red mullet in GSA 11. Length frequency distribution of striped red mullet caught within GSA 11 (number of individuals are given in thousands), 2005-2015

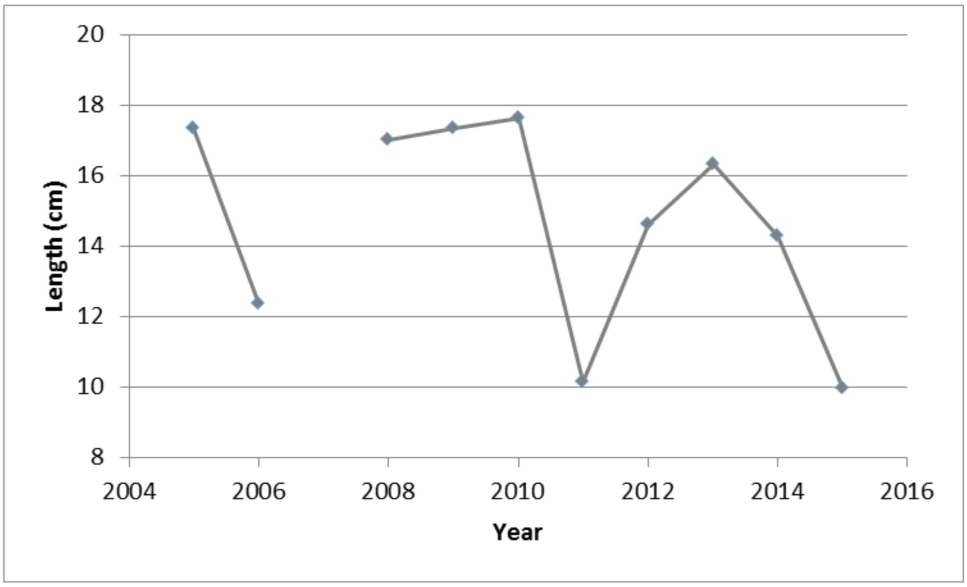


Figure 6.7.1.2.4. Striped red mullet in GSA 11. Oscillations of mean annual length values of striped red mullet caught within GSA 11, 2005-2015

Age frequency distribution is given on a Figure 6.7.1.2.5. According to otolith readings eleven age classes (0-10) were determined in analysed stock, while the most abundant ages in the catches were 1 and 2 along the whole period of investigation.

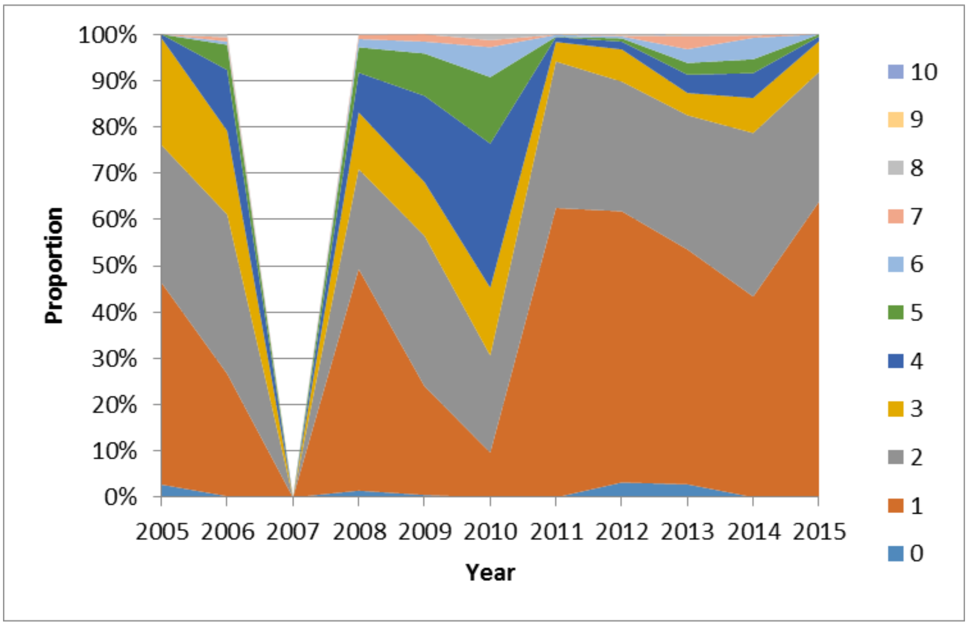


Figure 6.7.1.2.5. Striped red mullet in GSA 11. Age frequency distribution of striped red mullet caught within GSA 11, 2005-2015

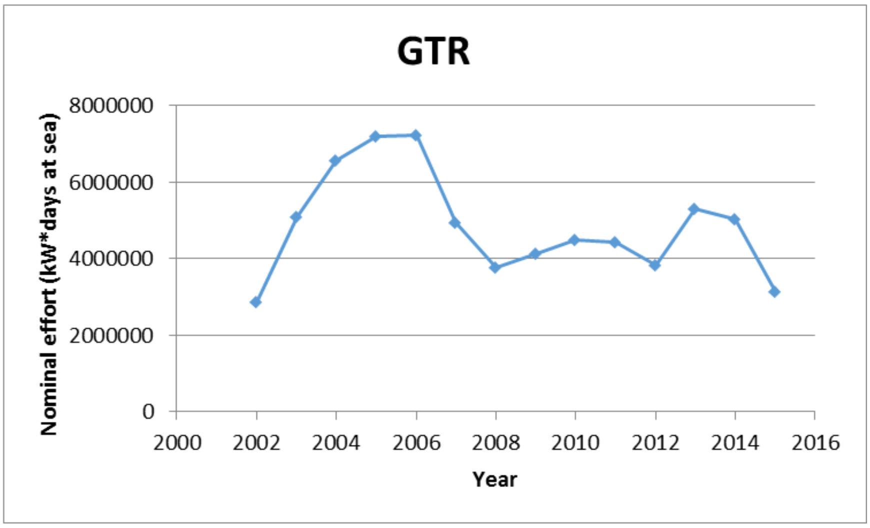
Discards

According to the official data submitted by Italy in response to the DCF data call striped red mullet is one of the species that was discarded. Those discards come from the same fishing gears that were catching it. Amount of the discarded striped red mullets varied over the years and it was highest in 2005 (186 t; 30% of overall striped red mullet catches in GSA 11) and the lowest in 2009 (9 t; 2.3% of overall striped red mullet catches in GSA 11). The length of discarded striped red mullet specimens also changed during the years as in 2005 length of discarded specimens ranged between 17 to 25 cm, afterwards length of discarded specimens was between 5 and 16 cm (except in 2012 when the length of discarded specimens went from 13 to 30 cm). No discards data were recorded in 2008 and 2013.

6.7.1.3 Fishing effort data

Considering the fact that majority of the striped red mullet catches were obtained by trammel nets (GTR) and bottom otter trawlers (OTB) their fishing effort only these fleets will be described. Nominal effort values alternations of both fishing gear are given in Figure 6.7.1.3.1.

a)



b)

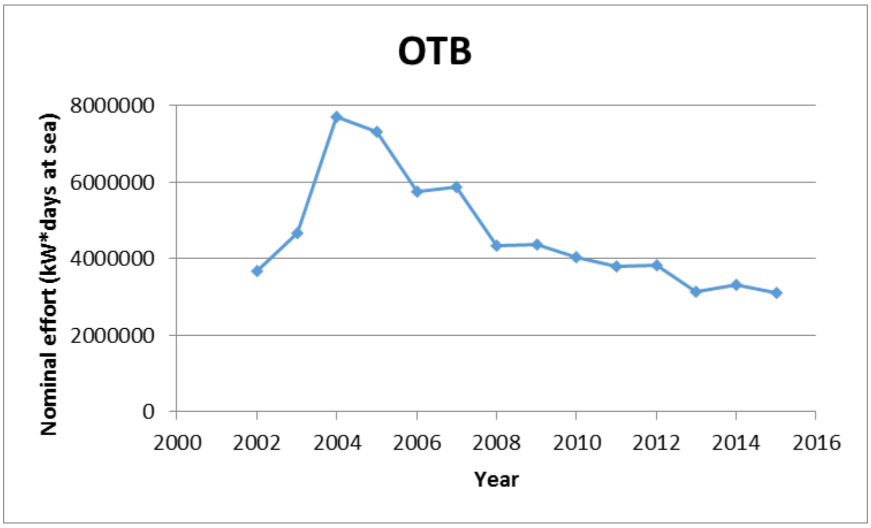
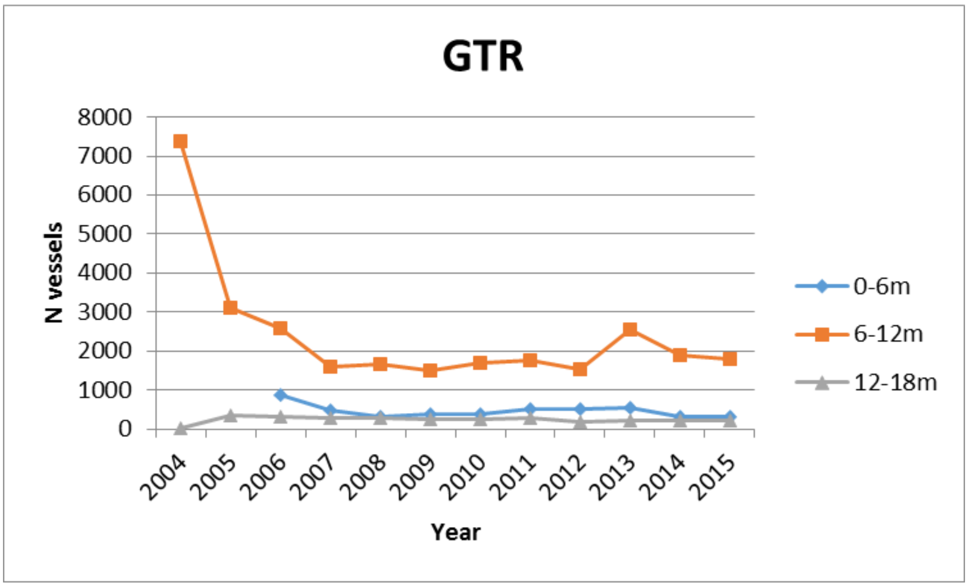


Figure 6.7.1.3.1. Striped red mullet in GSA 11. Changes of nominal effort values for trammel nets (GTR) (a) and bottom otter trawlers (OTB) (b) obtained from 2002 till 2015 in GSA 11.

According to values it seems that the nominal efforts of both gears that were fishing in GSA 11are slightly decreasing over the period. Also, we have to noticed that both gears had catches in 2007 but no striped red mullet catches/landing were reported according to EU DCF data call. Beside the values of nominal fishing effort, number of vessels also slightly decreases over time (Figure 6.7.1.3.2.). Generally, GTR fishing fleet in GSA 11 was mostly comprised of vessels which length was between 6 to 12m (≈76%), while OTB fishing fleet was made up of vessels which length was between 12 to 18 m by approximately 50% (2004-2015).

a)



b)

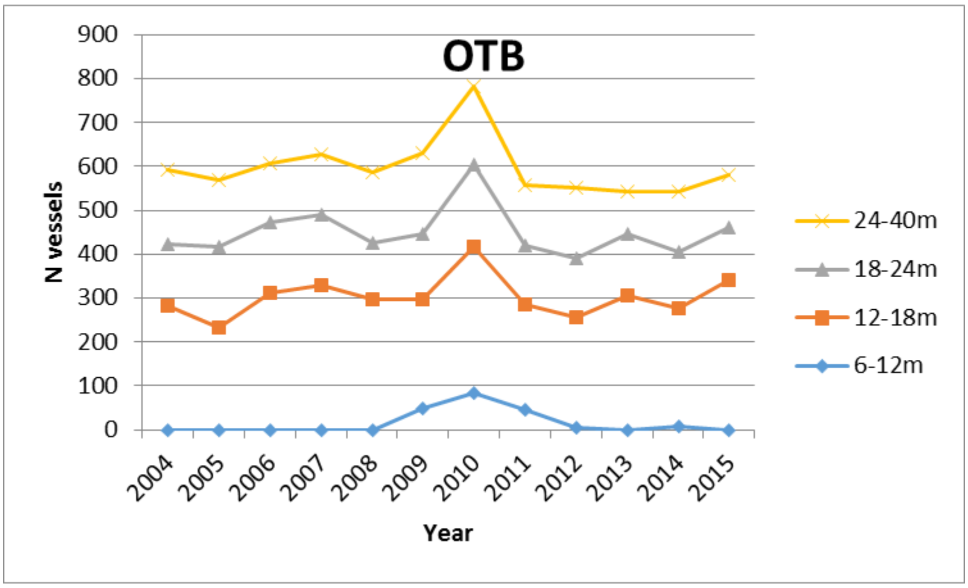


Figure 6.7.1.3.2. Striped red mullet in GSA 11. Number of vessels in the 0-6 m, 6-12 m, 12-18 m, 18-24 m and 24-40 m LOA fleet segments using trammel nets (GTR) and bottom otter trawlers (OTB) during 2004-2015.

6.7.1.4 Survey Indices of abundance and biomass by year and size/age

Since 1994, MEDITS trawl surveys has been regularly carried out each year during the spring season. Striped red mullet density showed large fluctuations and very high peak was detected in 2005. (Figure 6.7.1.4.1.).

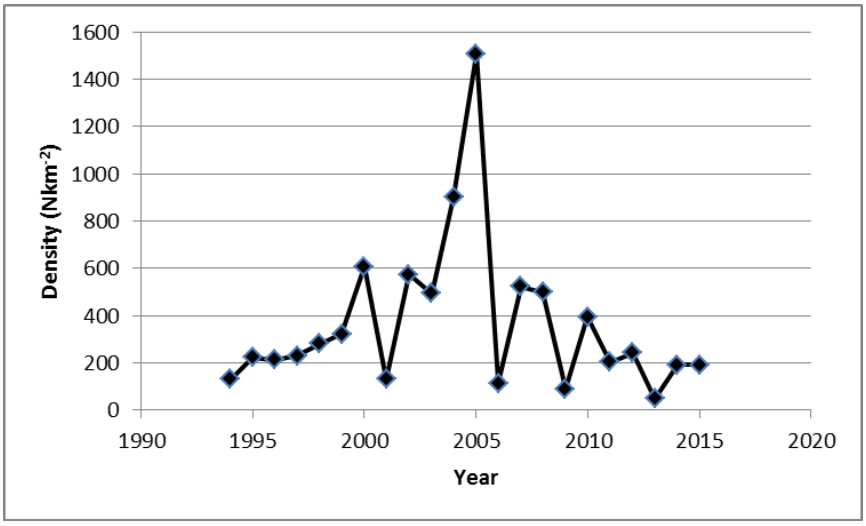


Figure 6.7.1.4.1. Striped red mullet in GSA 11. Striped red mullet density fluctuation obtained by the scientific survey MEDITS from 1994 till 2015

Length frequencies obtained each year during the MEDITS surveys were converted to ages by the given von Bertalanffy growth parameters for this stock and shown in Figure 6.7.1.4.2. From the presented data it is obvious that abundances of age 0 and 1 were not consistent over the years and that the abundance of the individuals age 0 more or less follows the trend of density obtained during the MEDITS surveys.

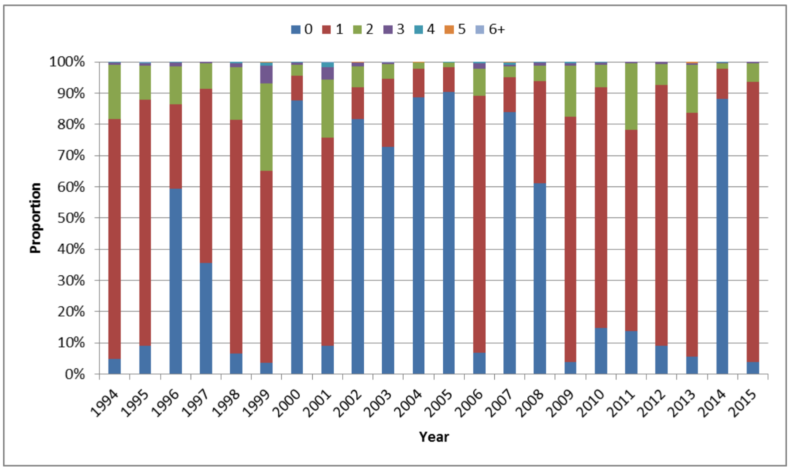


Figure 6.7.1.4.2. Striped red mullet in GSA 11. Striped red mullet age frequency distribution observed during MEDITS surveys from 1994 – 2015

6.7.2 STOCK ASSESSMENT ON STRIPED RED MULLET IN GSA 11

After comprehensive analysis of the data provided throughout the DCF data call by Italy for this area EWG noticed some inconsistency. First of all, due to the fact that data for striped red mullet are missing in 2007 EWG have to explore the possibility of running assessment only from 2008. Taking into account that this fish species was caught with different fishing gears it was decided that VIT assessment might be the best choice. During the preparation of data for VIT assessment it was noticed that over the years that were planned to be used (2008-2015) landings of some gears were lacking. Hence, VIT assessment should be done only for 2014 and 2015 when all important gears for this species were working. Unfortunately, age frequency distribution of sampled specimens in 2014 and 2015 seems to be odd (for example - in 2014 in collected samples of GTR number of collected specimens of age 2 and 4 was 158.522 and 25.978 thousands, respectively; while no specimens of age 3 were reported). This prevents proper assessment in VIT. Furthermore exploration of collected data, precisely number of sampled specimens by age multiply by provided weight at age reveal important deviation in reported catch/landed weight (SoPs). In some years this deviation was more than 15% (37 % in 2011, 50% in 2015). Taking into account all of this EWG was unable use the data supplied to evaluate the status of the striped red mullet stock in GSA 11.

Method 2. Length-based analysis

Length-based methods were used for deriving some indicators explored in WKLIFE IV. (ICES, 2015). They allow classifying the stocks according to conservation/sustainability, yield optimization and MSY considerations. Analysis required data on the stock catch/landings–length composition and life-history parameters as Linf.

The length-based indicators analysis was performed using the commercial landings in 2013to 2015 (discards considered negligible) and the following life-history parameters: L_{inf}=35.87 cm.

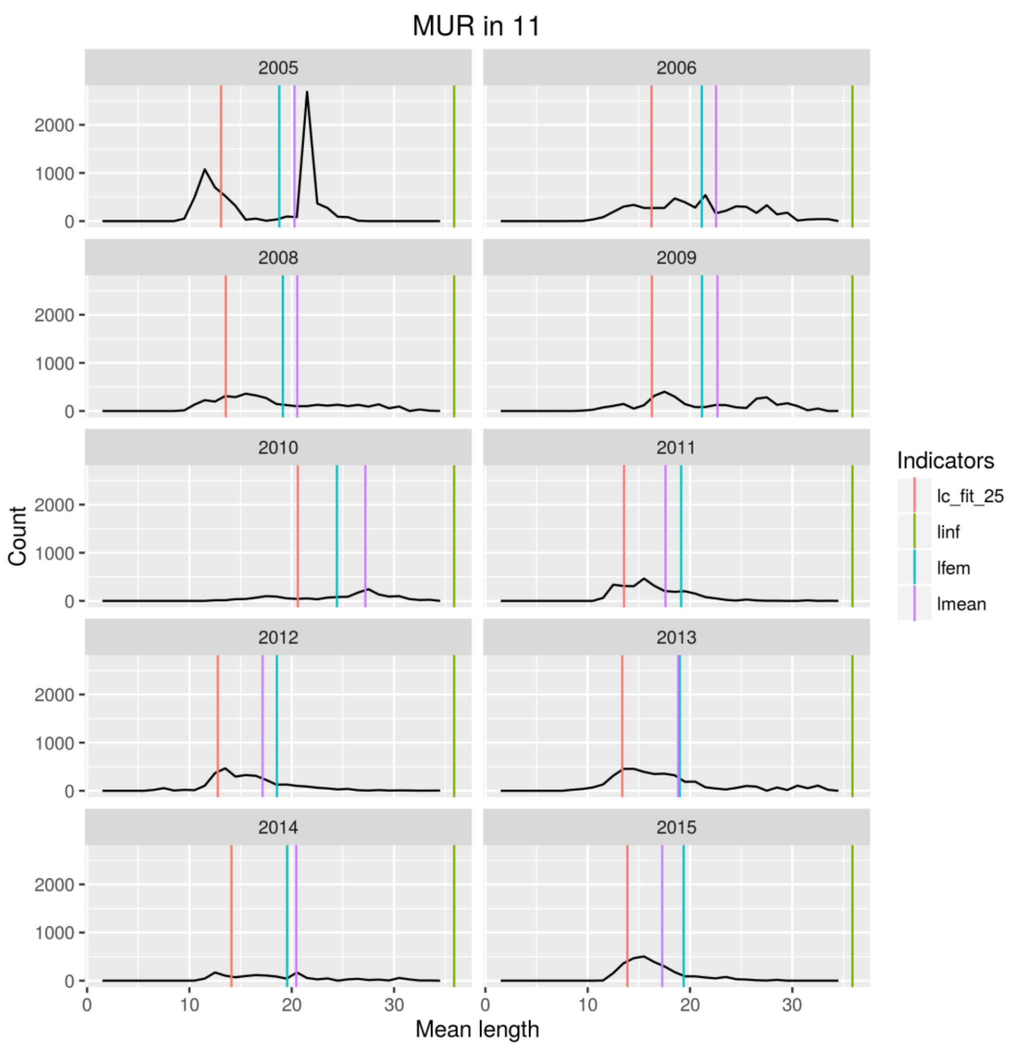


Figure 6.6.2.7. Striped Red Mullet in GSA 11. Length-based indicators and reference points for striped red mullet using the catch length composition for 2005, to 2015

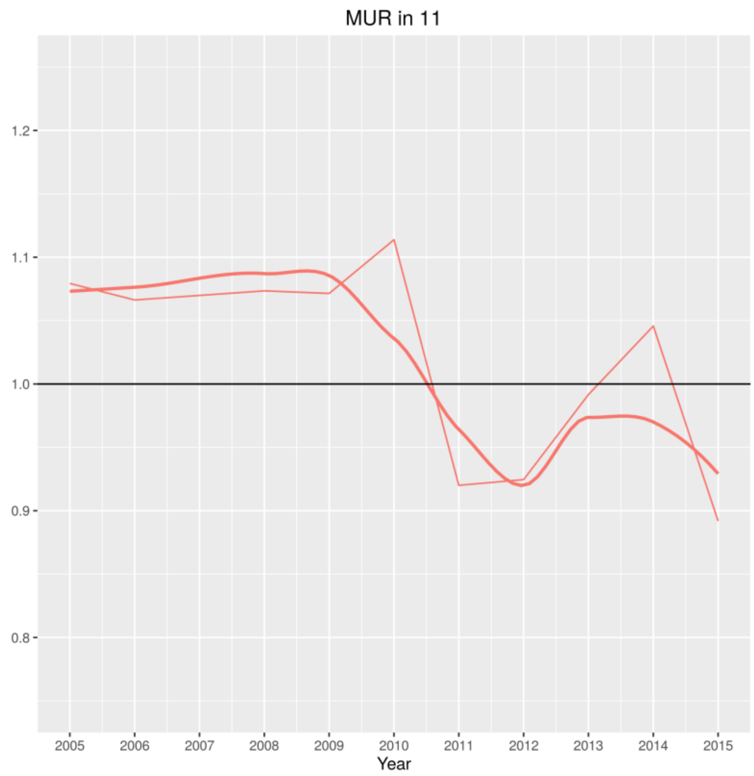


Figure 6.6.2.8. Striped red mullet in GSA 11. Length-based indicator for striped red mullet using the catch length composition for 2005 to 2015

The overall perception from length-based indicators is that the stock is being fished close to the MSY level. This is similar to striped mullet in GSA 9, but the year to year variability is much greater, suggesting the results are less informative than those for GSA 9.

6.7.3 REFERENCE POINT

As there is no assessment no reference point evaluation as carried out.

6.7.4 SHORT TERM FORECAST

As there is no assessment no short term forecast was conducted.

6.7.5 QUALITY AND PROPOSALS FOR FUTURE ASSESSMENTS

Catch data supplied showed inconsistencies throughout, both in terms of allocations to gear and SOP deviations. The data sets need to be checked.

6.8 NORWAY LOBSTER IN GSA 6

6.8.1 DATA GATHERING OF NORWAY LOBSTER IN GSA 6

6.8.1.1 Stock Identity and Biology

Due to the lack of information about the structure of the *N. norvegicus* population in the western Mediterranean, this stock was assumed to be confined within the GSA 6 boundaries (Figure 6.8.1.1.1).

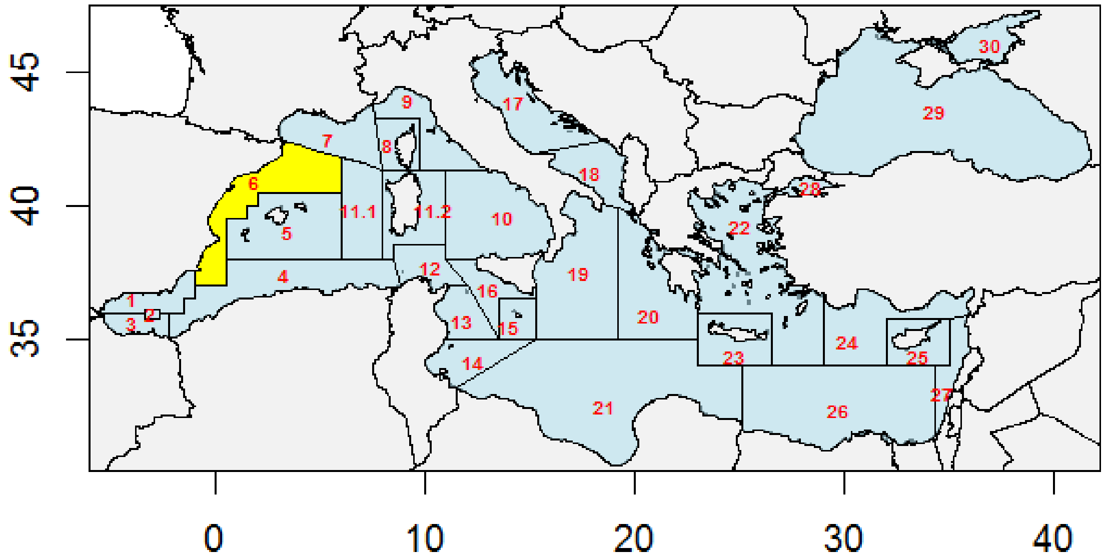


Figure 6.8.1.1.1. Geographical location of GSA 6.

Age and growth

For *N. norvegicus*, males and females are known to have different growth profiles, with males growing slower and reaching greater size than females. The DCF data did not include any information on the growth parameters of *N. norvegicus* in GSA 6. Also, the sex ratio in the catches was not available in the DCF for *N. norvegicus* in GSA 6. Growth parameters for both sexes combined were taken from GSA 9, as it has been done in the previous assessment of this stock (EWG 14-17) (Table 6.8.1.1.1)

Table 6.8.1.1.1. Norway lobster in GSA 6. Growth parameters (Linf, K, t0) and parameters of the Length-Weight relationship (a, b) used for the assessment of *N. norvegicus* in GSA 6 (taken from GSA 9) for both sexes combined.

Linf (mm)	K	t0	A	B
74.1	0.17	0	0.001	3.08

Maturity

No information on maturity at age of *N. norvegicus* in GSA 6 was available in the DCF. Maturity at age estimates for both sexes combined were taken from GSA 09 (Table 6.8.1.1.2).

Table 6.8.1.1.2. Norway lobster in GSA 6. Maturity at age of *N. norvegicus* in GSA 6 (taken from GSA 9) for both sexes combined.

Age	1	2	3	4	5	6	7+
Maturity	0.1	0.25	0.8	1.0	1.0	1.0	1.0

Feeding and Habitat

N. norvegicus is a mud-burrowing species that prefers sediments with mud mixed with silt and clay in variable proportions. The emergence from burrows of individuals may vary depending on biological features or environmental factors (moult or reproduction cycles, light intensity, etc.). The species lives at depths between 150 and 800 m (Biagi *et al*., 2002; Colloca *et al.*, 2003). In GSA 6 the highest abundances, both in numbers of individuals and in biomass, are located in the 200-500 m depth stratum (Abelló et al., 2002). Recruitment takes places in spring-summer and autumn. The species is an active predator or scavenger, feeding on detritus, crustaceans and worms (Holthuis 1991).

Natural mortality

The natural mortality vector for *N. norvegicus* in GSA 6 was calculated using Prodbiom (Abella et al. 1997) (Table 6.8.1.1.3).

Table 6.8.1.1.3. Norway lobster in GSA 6. Natural mortality vector for *N. norvegicus* in GSA 6 for both sexes combined.

Age	1	2	3	4	5	6	7+
M	0.48	0.36	0.3	0.27	0.26	0.24	0.23

6.8.1.2 Catch data

Landings

Landings of *N. norvegicus* in GSA 6 are reported only by trawlers (OTB) (Figure 6.8.1.2.1, Table 6.8.1.2.1). According to the available DCF data, the landings of *N. norvegicus* were at a minimum of 187 tonnes in 2002 and reached a maximum of 506 tons in 2012. Total landings had an overall increasing trend during 2002-2014, followed by a substantial decrease in 2015.

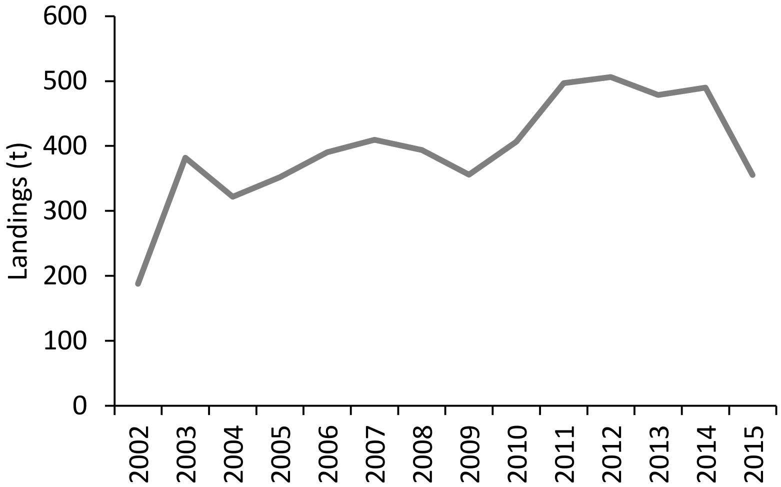


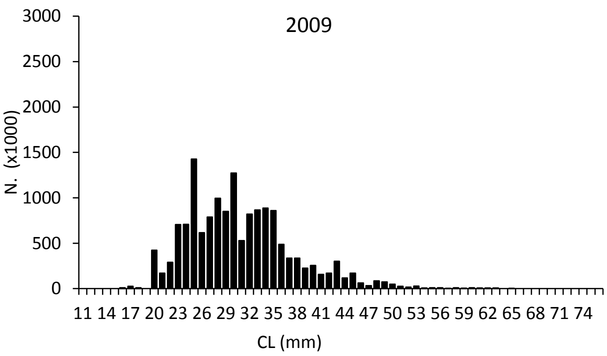
Figure 6.8.1.2.1. Norway lobster in GSA 6. OTB landings (tonnes) of *N. norvegicus* in GSA 6 from 2002 to 2015.

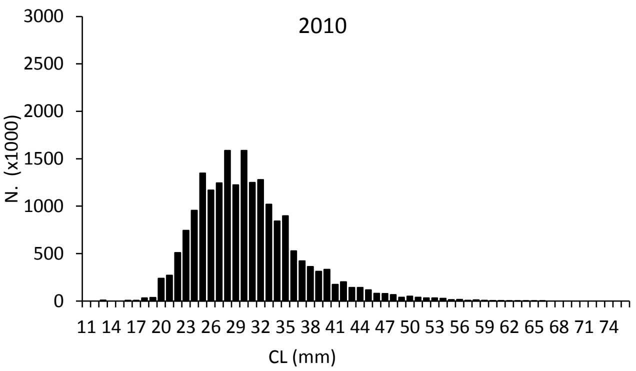
Table 6.8.1.2.1. Norway lobster in GSA 6. OTB landings (tonnes) of *N. norvegicus* in GSA 6 from 2002 to 2015.

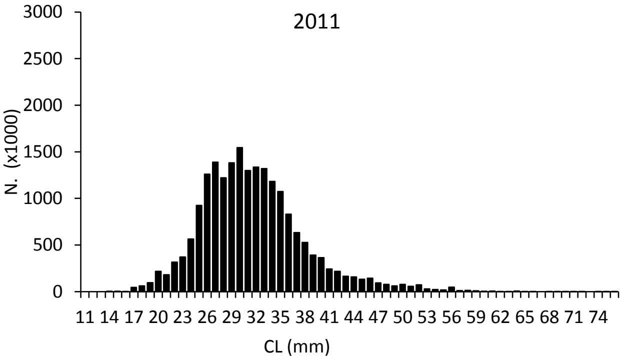
Year	Landings
2002	187.50

2003	381.81
2004	321.72
2005	351.99
2006	390.18
2007	409.40
2008	393.77
2009	355.60
2010	406.45
2011	496.84
2012	506.09
2013	478.36
2014	489.95
2015	355.24

Landings LFDs were only available for 2009-2015. Therefore, these were the years for which the assessment was carried out. Landings were primarily composed by specimens ranging from 20 to 50 mm CL (Figure 6.8.1.2.2) and aged 2-3 years old (Figure 6.8.1.2.3). No particular changes in the shapes of the LFDs were observed from year to year. LFDs were not reported for the métier “Mixed demersal and deep water species” (OTB - MDDWSP) in the DCF data, therefore available annual LFDs from the other OTB métiers were used to calculate MDDWSP LFDs from 2009 to 2015. An age-sliced landings at age matrix was calculated to be used in the assessment, using the LFDA programme (Figure 6.8.1.2.3b). This age-sliced landings at age matrix was preferred to the landings at age information in the DCF data (Figure 6.8.1.2.3a), because the growth parameters used for the age-slicing in the DCF data were unknown. In any case, the recalculated landings at age matrix based on age-slicing did not exhibit substantial differences with the one reported in the DCF (Figure 6.8.1.2.3).






2011
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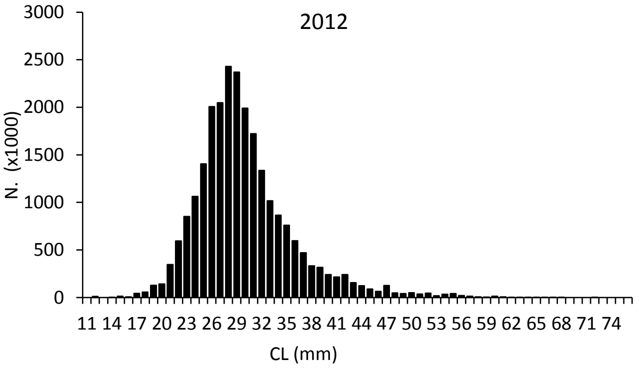
3000
2500
2000
1500
1000
500
0
11 14 17 20 23 26 29 32 35 38 41 44 47 50 53 56 59 62 65 68 71 74
CL (mm)


2012
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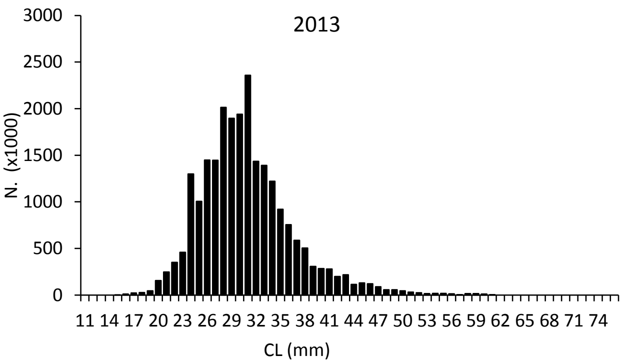
11 14 17 20 23 26 29 32 35 38 41 44 47 50 53 56 59 62 65 68 71 74
CL (mm)


2013
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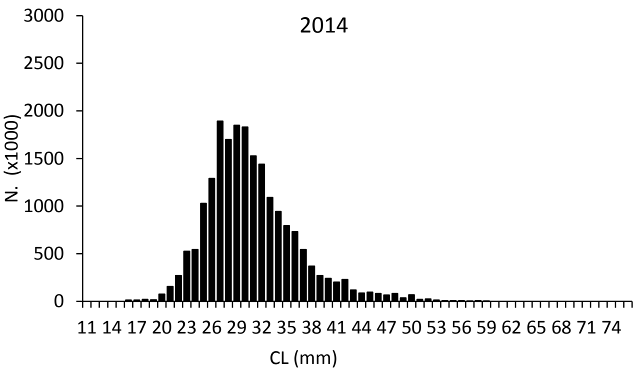
CL (mm)


2014
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CL (mm)

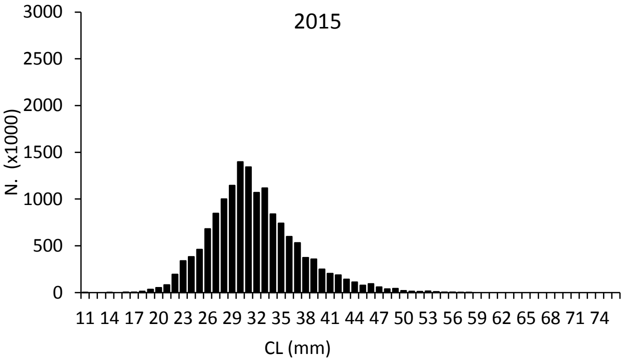


Figure 6.8.1.2.2. Norway lobster in GSA 6. LFDs of *N. norvegicus* landings in GSA 6

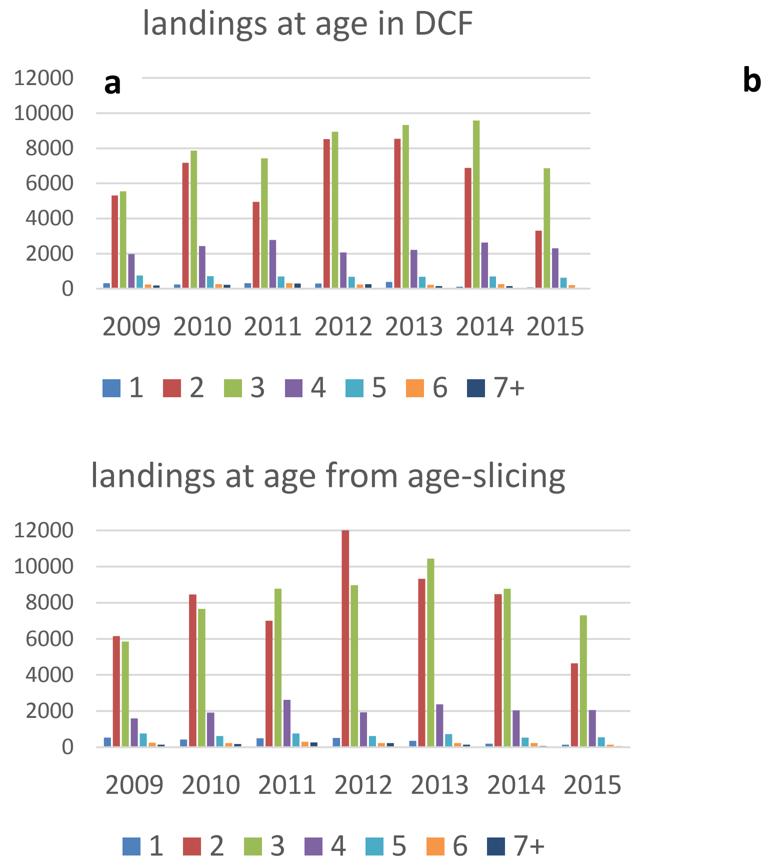


Figure 6.8.1.2.3. Norway lobster in GSA 6. Landings at age of *N. norvegicus* in GSA 6 in the DCF data (a) and calculated from the age-slicing of LFDs (b). Coloured bars indicate the different age classes.

Discards

Discards of *N. norvegicus* in GSA 6 were only reported in 2009-2015, and they varied from 0.01 tonnes (2009) to 65.80 (2012) tonnes (Table 6.8.1.2.2). The DCF data did not include any information on the LFDs of discards. Due to their high variability and lack of LFDs, discard data were not included in the assessment.

Table 6.8.1.2.2. Norway lobster in GSA 6. OTB discards (t) of *N. norvegicus* in GSA 6.

Year	Discards (tonnes)

2009	0.01
2010	0.06
2011	11.37
2012	65.80
2013	12.34
2014	10.84
2015	6.34

The discards to landings ratio was less than 3% in all years, except year 2012 when it was 13%.

6.8.1.3 Fishing effort data

DCF data available for the OTB fishing effort in GSA 6 spanned from 2004 to 2015. During that period, OTB effort exhibited a decreasing trend both in terms of time (Days at sea) and in terms of fishing power (kW*Days at Sea) (Figure 6.8.1.3.1b, c; Table 6.8.1.3.1). The number of vessels using OTB has not exhibited any consistent trend (Figure 6.8.1.3.1a).

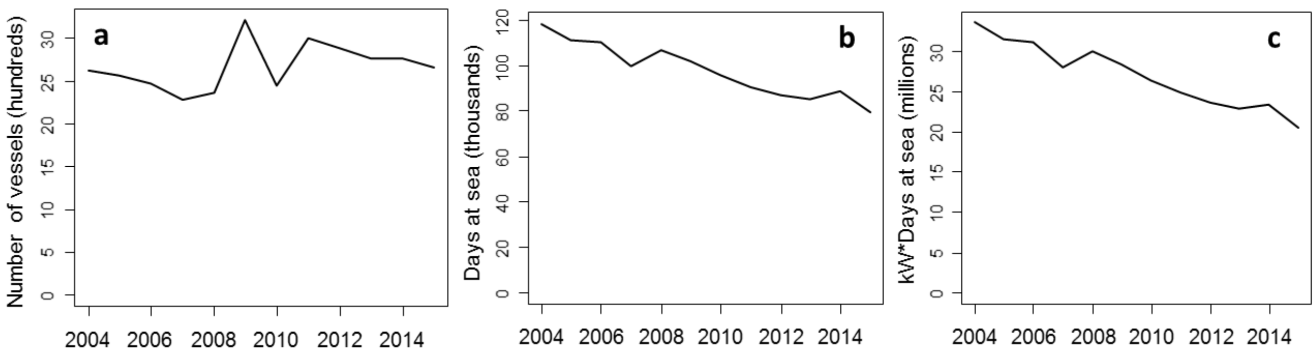


Figure 6.8.1.3.1. Norway lobster in GSA 6. Temporal development of OTB fishing effort in GSA 6 in 2004-2015 in terms of number of vessels (a), days at sea (b), and kW*Days at sea (c).

Table 6.8.1.3.1. Norway lobster in GSA 6. OTB effort in GSA 6

Year	Number of vessels	Days at sea	kW*Days at sea
2004	2623	118076	33561273
2005	2567	110957	31446673
2006	2472	110008	31080081
2007	2275	99638	27966130
2008	2356	106867	29956899
2009	3220	102005	28339356
2010	2447	95438	26306047
2011	3002	90470	24805884
2012	2888	86587	23553925
2013	2764	84882	22821990
2014	2766	88528	23422870
2015	2663	79421	20513126

CPUE of *N. norvegicus* in GSA 6 exhibited an overall increasing trend in 2004-2012 followed by a stabilisation in 2012-2014 and a drop in 2015 (Figure 6.8.1.3.2).

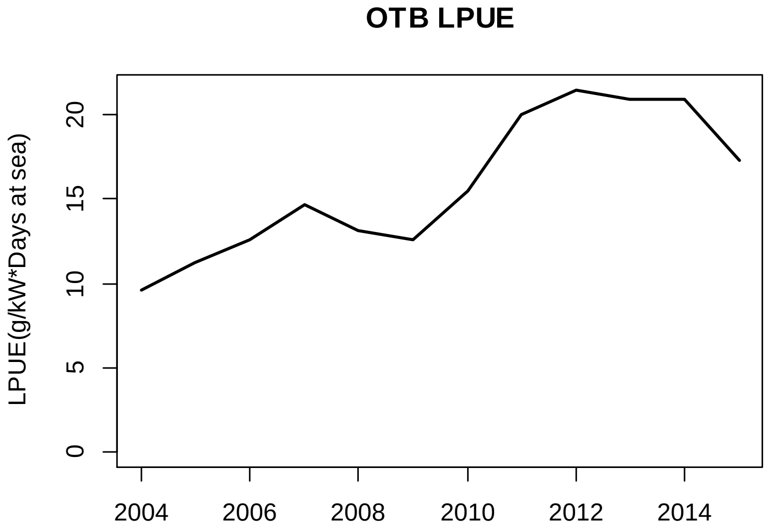


Figure 6.8.1.3.2. Norway lobster in GSA 6. Temporal development of OTB LPUE for *N. norvegicus* in GSA 6 in 2004-2015

6.8.1.4 Survey Indices of abundance and biomass by year and size/age

The MEDITS survey (Table 6.8.1.4.1) was used to infer abundance and biomass indices for *N. norvegicus* in GSA 6. It was noted that some entries in the MEDITS LFD data were in millimetres instead of centimetres and these were corrected. These erroneous entries were (by entry id): 3407785-89, 3436154, 3446194-95, 3503235 and 3580944.

Table 6.8.1.4.1. Norway lobster in GSA 6. Number of MEDITS hauls for each depth stratum in GSA 6 in 1994-2015. A: 10-49 m, B: 50-99 m, C: 100-199 m, D: 200-499 m, E: 500-800 m.

Year/ Stratum	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
A	7	8	7	8	7	8	9	7	10	8	7	9	11	5	7	6	5	7	9	10	10	9
B	21	27	27	25	27	28	30	29	34	37	31	33	33	26	29	28	20	28	34	38	40	36
C	10	18	15	14	12	16	18	18	19	20	16	17	18	14	20	21	12	20	22	24	25	27
D	9	15	11	10	6	12	11	15	17	16	16	14	17	10	13	11	10	17	17	18	19	20
E	8	11	9	8	4	10	7	8	6	12	10	8	12	9	9	9	8	6	8	7	8	12
Total	**55**	**79**	**69**	**65**	**56**	**74**	**75**	**77**	**86**	**93**	**80**	**81**	**91**	**64**	**78**	**75**	**55**	**78**	**90**	**97**	**102**	**104**

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953;

Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

Yst = Σ (Yi*Ai) / A
V(Yst) = Σ (Ai2 * si 2 / ni) / A2

Where:
A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval:
Confidence interval = Yst ± t(student distribution) * V(Yst) / n
Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA.

The MEDITS indices indicated fluctuations with no particular trend in 1994-2013 followed by an abrupt decrease in 2014 and 2015 corresponding to the lowest index levels observed (Figure 6.8.1.4.1). Comparing the trends of the MEDITS indices with these of landings (Figure 6.8.1.2.1) and CPUE (Figure 6.8.1.3.2) in 2009-2015, which were the years of the assessment, indicated some distinct discrepancies. Year 2009 had the highest MEDITS index values but corresponded to the lowest Catch/CPUE values, while the abrupt decrease of the MEDITS indices in 2014 was not observed in the Catches/CPUE trends.

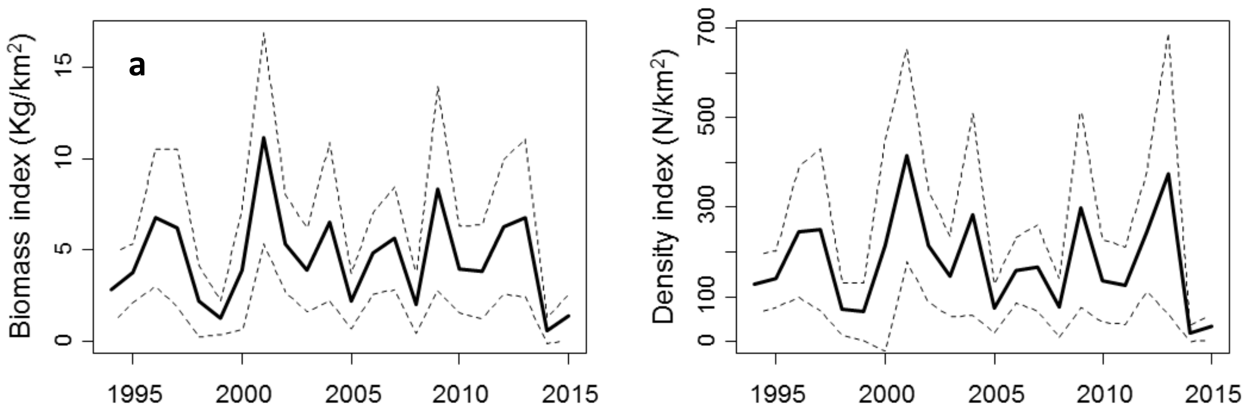


Figure 6.8.1.4.1. Norway lobster in GSA 6. Standardised biomass and density indices for *N. norvegicus* in GSA 6 based on MEDITS data. Dashed lines indicate 95% confidence intervals.

MEDITS *N. norvegicus* samples from GSA 6 were primarily composed by specimens ranging from 15 to 50 mm CL (Figure 6.8.1.4.2) and aged 2-3 years old (Figure 6.8.1.4.3). In terms of size distribution, MEDITS LFDs were similar to these from landings.

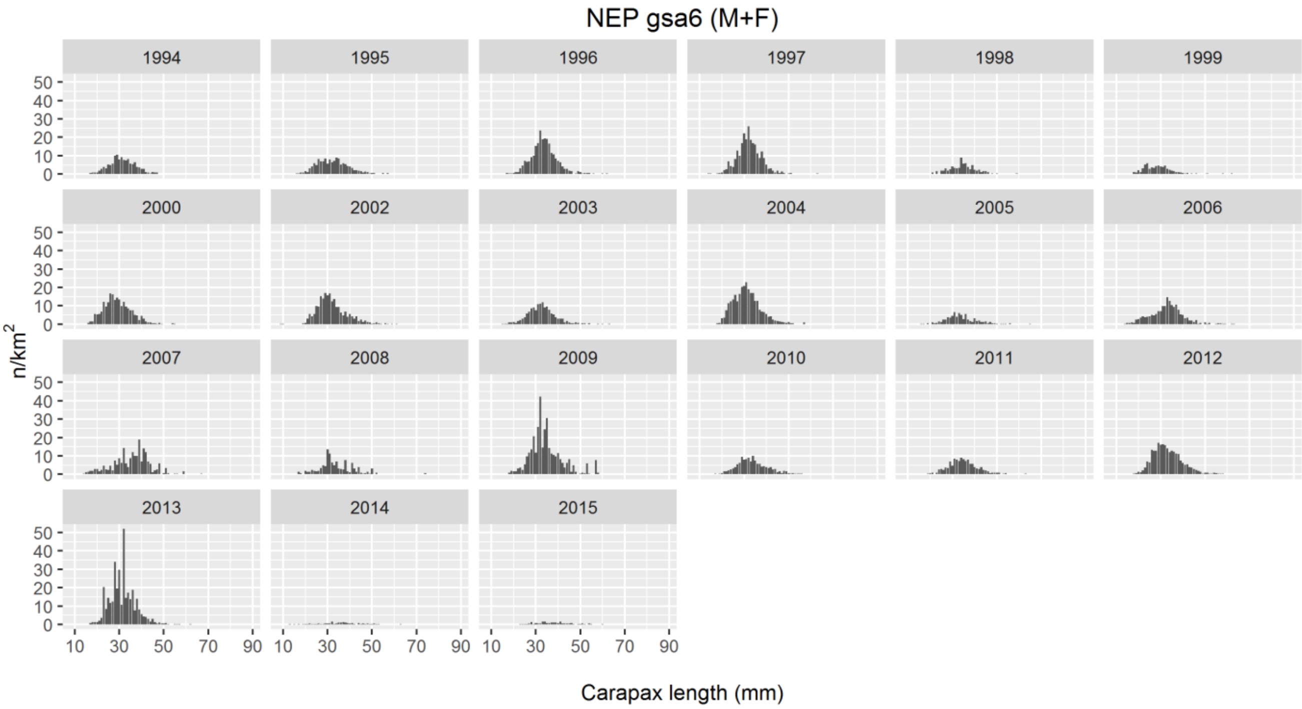


Figure 6.8.1.4.2. Norway lobster in GSA 6. LFDs of *N. norvegicus* sampled by MEDITS in GSA 6 during 1994-2015. Year 2001 has been omitted due to the use of length classes of different size (5 cm instead of 1 cm).

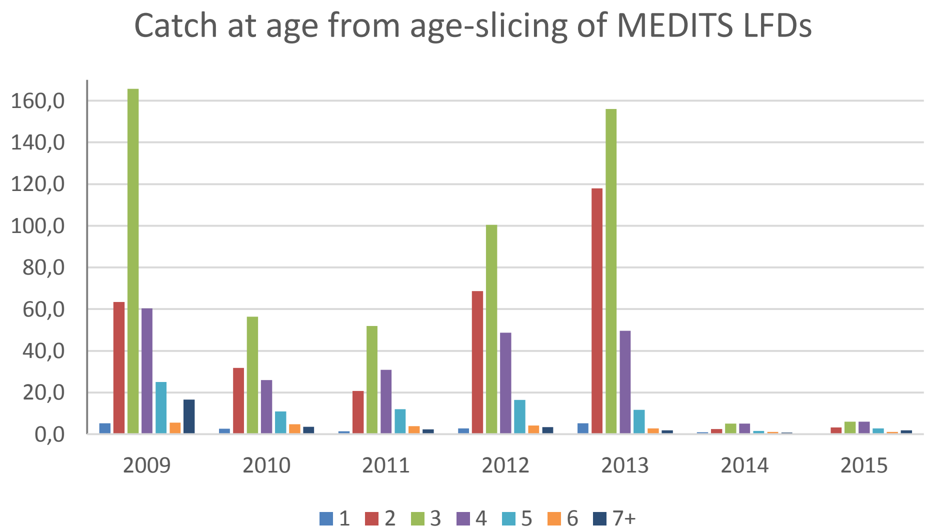


Figure 6.8.1.4.3. Norway lobster in GSA 6. Age distribution of *N. norvegicus* derived from age-slicing of MEDITS data in 2009-2015. Coloured bars indicate the different age classes.

6.8.2 STOCK ASSESSMENT ON NORWAY LOBSTER IN GSA 6

The last assessment of this stock by STECF was carried out in 2014 by means of a pseudocohort analysis (VIT) for years 2009-2013. Due to the inclusion of more years in the time-series since then, VPA methods were used here.

Method 1- XSA

An assessment was carried out using an XSA applied to an age-structured data series of seven years (from 2009 to 2015). Data coming from the MEDITS survey were used for tuning.

XSA input parameters

As described in 6.8.1, data from the DCF available to EWG 16-17 included, for *N. norvegicus* in GSA 6, information on landings and the respective size structure for 2009-2015 (Figure 6.8.1.2.2). After age-slicing the landings LFDs, plus group was set at age 7. The number of individuals caught by age was then SOP corrected [SOP = Landings / Σa (total catch numbers at age a x catch weight-at-age a)] (Table 6.8.2.1).

Table 6.8.2.1. Norway lobster in GSA 6. Catch at age matrix (in thousands) for *N. norvegicus* in GSA 6 used in the XSA and separable VPA, together with the SOP correction factor applied.

Year/Age	1	2	3	4	5	6	7+	SOP
2009	531.7	6155.8	5849.8	1598.8	762.3	245.7	140.9	1.067
2010	424.4	8463.7	7653.1	1920.8	622.3	224.9	171.3	1.027
2011	494.7	6998.4	8768.7	2621.9	758.5	305.5	272.9	1.106
2012	524.8	12052.9	8962.2	1939.3	616.8	236.5	228.7	1.104
2013	351.0	9325.5	10441.9	2380.4	730.7	231.5	151.0	1.018
2014	193.2	8466.5	8770.0	2043.9	540.0	238.3	78.2	1.194
2015	136.4	4652.8	7301.8	2060.6	554.2	146.0	48.6	1.100

Weights at age for *N. norvegicus* in GSA 6 were taken from the DCF data (Table 6.8.2.2). Given that slightly different weights at age were reported by different metiers and in different quarters, a weighted average of weight at age was calculated for each age class in every year. Weights at age in the catch were assumed to be the same with weights at age in the stock.

Table 6.8.2.2. Norway lobster in GSA 6. Weights at age matrix (in Kg) for *N. norvegicus* in GSA 6 used in the XSA and separable VPA.

Year/Age	1	2	3	4	5	6	7+
2009	0.005	0.011	0.022	0.035	0.056	0.077	0.119
2010	0.005	0.011	0.021	0.036	0.055	0.075	0.114
2011	0.004	0.011	0.021	0.035	0.055	0.074	0.110
2012	0.004	0.011	0.020	0.035	0.053	0.074	0.115
2013	0.005	0.011	0.020	0.035	0.054	0.074	0.111
2014	0.004	0.012	0.021	0.034	0.054	0.073	0.101
2015	0.004	0.011	0.021	0.035	0.054	0.074	0.102

MEDITS indices for *N. norvegicus* in GSA 6 (Table 6.8.2.3) were taken from the DCF data, and were used after applying a standardisation described in 6.8.2.4.

Table 6.8.2.3. Norway lobster in GSA 6. MEDITS density indices (n/km^2) for *N. norvegicus* in GSA 6 used in the XSA.

Year/Age	1	2	3	4	5	6	7+
2009	5.3	63.5	165.7	60.3	25.1	5.5	16.6
2010	2.6	31.8	56.4	25.9	10.9	4.7	3.6
2011	1.4	20.7	51.9	30.9	12.0	3.8	2.3
2012	2.7	68.7	100.5	48.7	16.5	4.1	3.4

2013	5.2	117.9	156.1	49.6	11.7	2.8	1.8
2014	1.0	2.4	5.0	5.0	1.6	1.1	0.7
2015	0.2	3.2	6.0	6.0	2.7	1.1	1.9

The maturity and natural mortality (M) vectors used in the assessment are shown in Tables 6.8.1.1.2, 6.8.1.1.3. Proportion of F and M before spawning were set to 0.5.

XSA results

A sensitivity analysis testing different shrinkage weights (Sh 0.5, 1.0, 1.5 and 2.0) was carried out (Figure 6.8.2.1). Also, the effect of a range of different rage, qage and shk.ages values was explored, and rage = 1, qage = 4 and shk.ages = 4 were selected. The XSA results suggested that SSB exhibited a persistent decreasing trend in 2010-2015, while F(2-6) increased during the same period. F(2-6) of all the four different runs was approximately 0.8 in 2013 and was higher than that in 2014 and 2015.

In all cases, residuals from the tuning index (MEDITS) by age and year exhibited problematic patterns (Figure 6.8.2.2). Ages 2-5 in years 2014 and 2015 exhibited much higher abundances in the XSA compared to MEDITS, due to the very low values of the MEDITS index in these years. Years 2009, 2012 and 2013 also exhibited problematic residuals, albeit to a lesser extent than years 2014 and 2015, with MEDITS indicating higher abundances than the XSA for ages 2-5 (Figure 6.8.2.2). These mismatches between the results of the XSA and the MEDITS were due to the opposite trends of the landings and MEDITS index in 2009-2015, which were discussed in Section 6.8.1.4.

The XSA outputs suggested that the landings and MEDITS data were incompatible for *N. norvegicus* in GSA 6, therefore the XSA was rejected and no final run was selected.

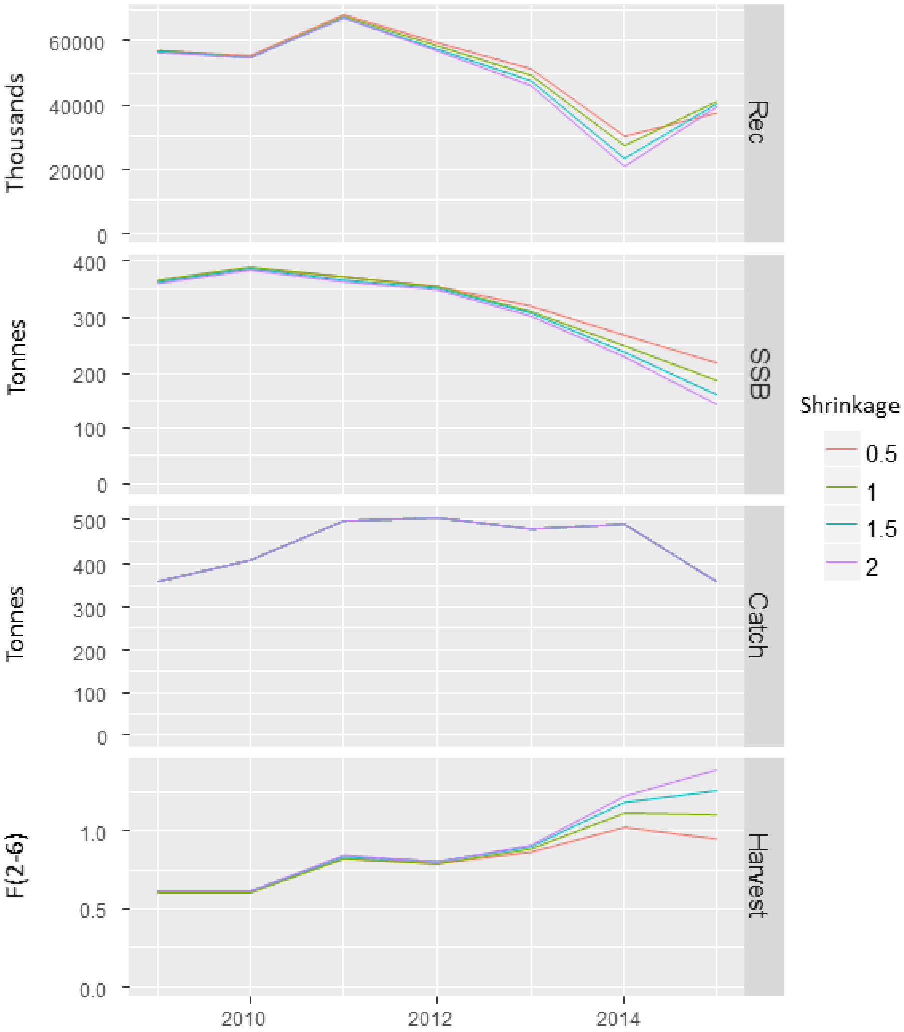


Figure 6.8.2.1 Norway lobster in GSA 6. Estimates of recruitment, SSB, Catch and F(2-6) of *N. norvegicus* in GSA 6 for different shrinkage settings.

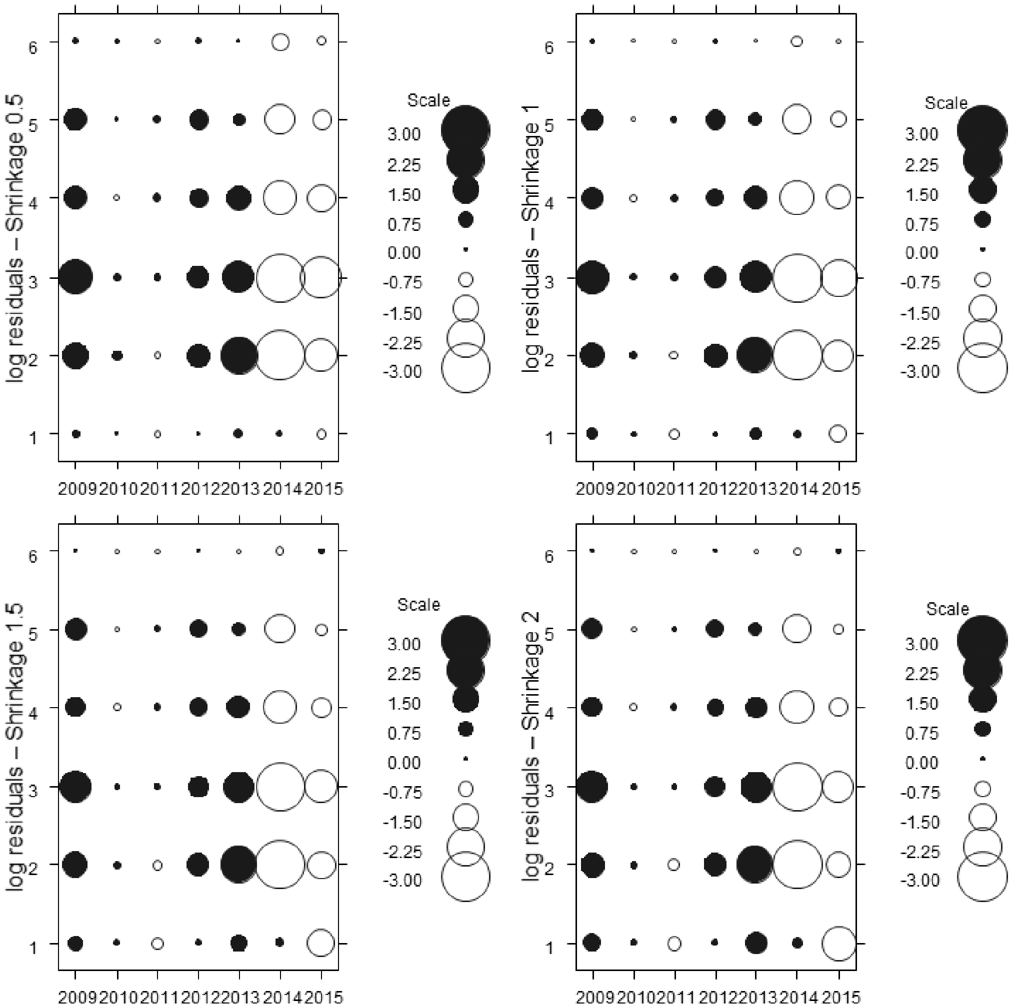


Figure 6.8.2.2. Norway lobster in GSA 6. Bubble plots of residuals of XSAs with different shrinkage settings compared to MEDITS for *N. norvegicus* in GSA 6.

Method 2- Separable VPA

Due to the discrepancy between the Landings and MEDITS index, which caused the rejection of the XSA, a separable VPA was also carried out for *N. norvegicus* in GSA 6. This type of assessment is carried out using landings data alone, without a tuning index.

Separable VPA input parameters

The input parameters used for the separable VPA (catch at age with SOP correction, weights at age, biological parameters) were the same with these used for the XSA (Tables 6.8.1.1.2, 6.8.1.1.3, 6.8.2.1, 6.8.2.2). No tuning index was used.

Separable VPA results

The separable VPA is particular sensitive to the choice of the terminal F (Fterm; F of the last age class in the last year) and the choice of the ratio between the F of the fully selected age class and terminal F ('sep.sel') that defines the shape of the F-at-age curve. Previous assessments (EWG 14-17) and the XSA performed by EWG 16-17 indicated the existence of a dome-shaped F-at-age curve for this stock; therefore, different sep.sel parameters (1.2, 1.5, 1.75, 2) resulting in different degrees of reduced selection of larger individuals were tried in combination with eight different values of Fterm. Best fits were obtained using sep.sel values of 1.2. and 1.5 (Figure 6.8.2.3.).

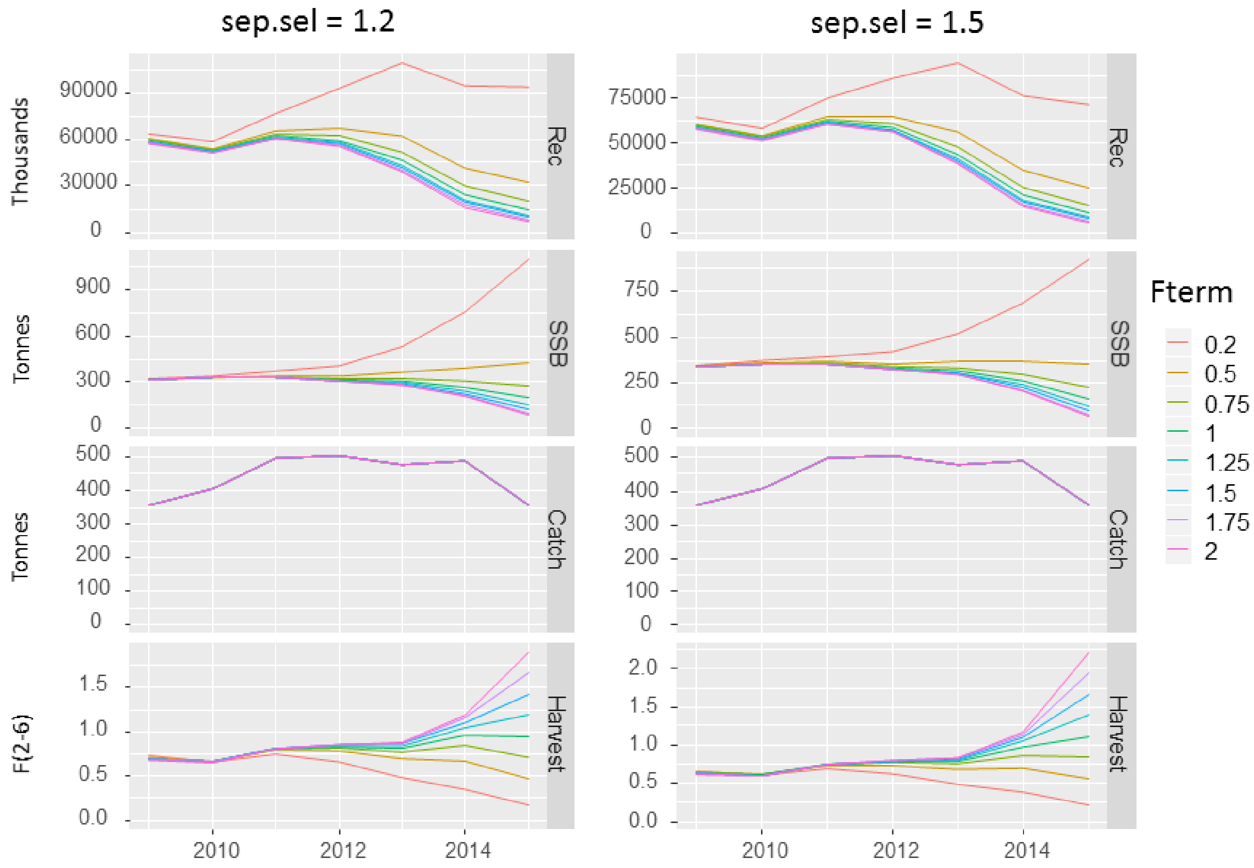


Figure 6.8.2.3. Norway lobster in GSA 6. Estimates of recruitment, SSB, Catch and F(2-6) of *N. norvegicus* in GSA 6 for different Fterm and sep.sel combinations.

To check the goodness of fit of the different separable VPAs on the data, the sum of residuals of the estimated catch by age and year using Baranov's catch equation from the observed catch by age and year were calculated. The three runs with the lowest sums of residuals was obtained for sep.sel = 1.2 and Fterm = 1.5, 1.75 or 2 (Figure 6.8.2.4). The best run was obtained for sep.sel = 1.2 and Fterm = 1.75 (Figure 6.8.2.5, Table 6.8.2.4, 6.8.2.5). Notably, in all separable VPAs with good fits (sep.sel = 1.2 or 1.5 and Fterm>1) SSB exhibited a decreasing trend after 2010 and F(2-6) in 2014 and 2015 was higher than that in 2013. In all these runs, F(2-6) in 2013 was approximately 0.8 (Figure 6.8.2.3).

All the most plausible runs converge in terms of SSB and F by 2013, following this the rates of change in SSB and F are sensitive to choice of terminal F but all support an increasing F and decreasing SSB from 2013 to 2015. Due to the model uncertainties after 2013 F and SSB in 2015 could not be estimated sufficiently accurately, and no specific single separable VPA run was selected for advice and short-term forecasts.

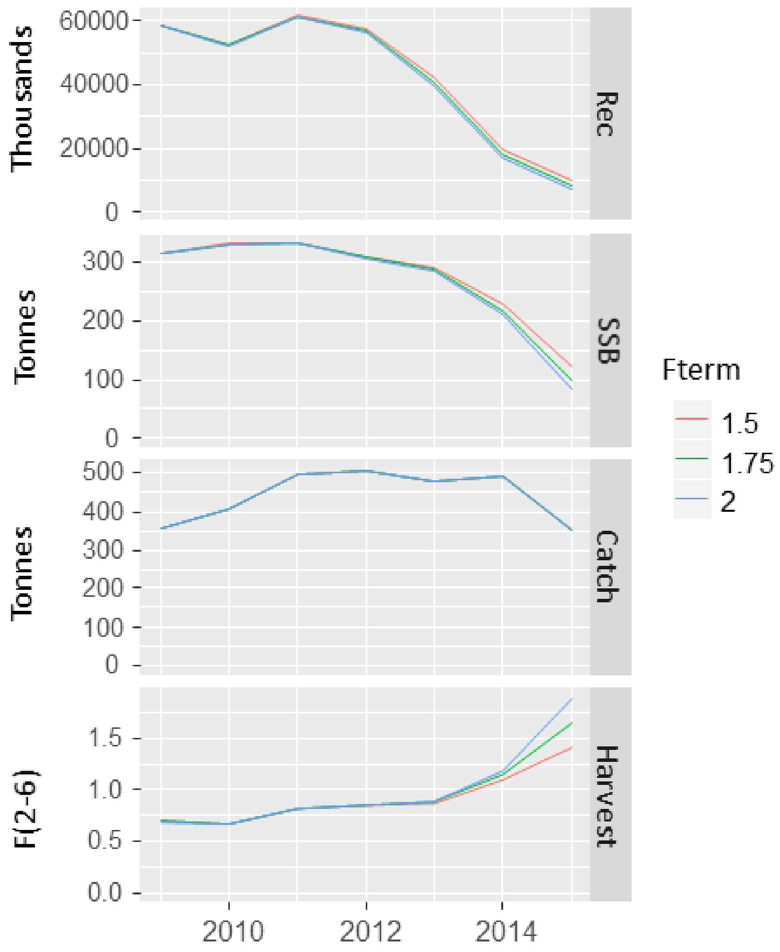


Figure 6.8.2.4. Norway lobster in GSA 6. Estimates of recruitment, SSB, Catch and F(2-6) of *N. norvegicus* in GSA 6 from the three optimal separable VPAs (sep.sel = 1.2 and Fterm = 1.5 - 2).

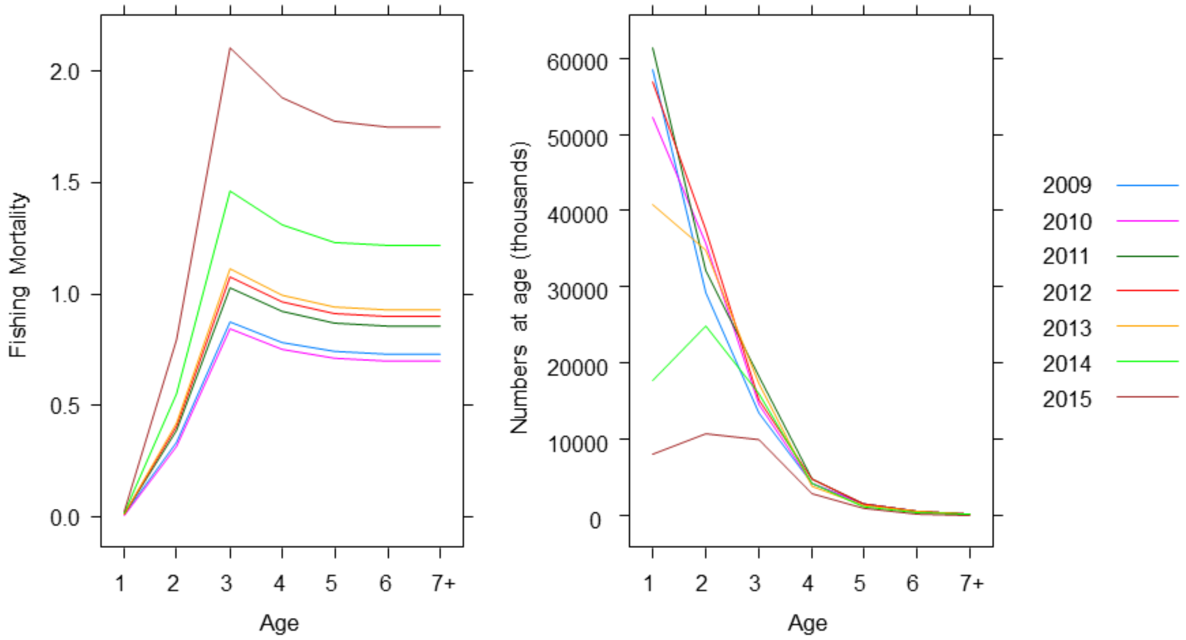


Figure 6.8.2.5. Norway lobster in GSA 6. Fishing mortality at age and Numbers at age in 2009-2015 of *N. norvegicus* in GSA 6 from the optimal separable VPA (sep.sel = 1.2 and Fterm = 1.75).

Table 6.8.2.4. Norway lobster in GSA 6**.** Fishing mortality at age in 2009-2015 of *N. norvegicus* in GSA 6 from the optimal separable VPA (sep.sel = 1.2 and Fterm = 1.75).

Age/Year	2009	2010	2011	2012	2013	2014	2015
1	0.010	0.010	0.012	0.012	0.013	0.017	0.024
2	0.332	0.319	0.390	0.410	0.422	0.554	0.797
3	0.875	0.839	1.027	1.081	1.110	1.458	2.100
4	0.784	0.752	0.920	0.968	0.994	1.306	1.880
5	0.739	0.709	0.868	0.913	0.938	1.232	1.774
6	0.729	0.700	0.856	0.900	0.925	1.215	1.750
7+	0.729	0.700	0.856	0.900	0.925	1.215	1.750
F(2-6)	**0.692**	**0.664**	**0.812**	**0.854**	**0.878**	**1.153**	**1.660**

Table 6.8.2.5. Norway lobster in GSA 6. Numbers at age in 2009-2015 of *N. norvegicus* in GSA 6 from the optimal separable VPA (sep.sel = 1.2 and Fterm = 1.75).

Age/Year	2009	2010	2011	2012	2013	2014	2015
1	58406	52301	61212	56933	40655	17709	7987
2	29276	35782	32055	37437	34798	24841	10778
3	13401	14649	18150	15142	17329	15926	9961
4	4118	4137	4687	4815	3807	4229	2745
5	1551	1435	1489	1427	1397	1075	875
6	561	571	545	482	442	422	242
7+	95	110	198	168	103	66	41

Method 3. Length-based analysis

Length-based methods were used for deriving some indicators explored in WKLIFE IV. (ICES, 2015). They allow classifying the stocks according to conservation/sustainability, yield optimization and MSY considerations. Analysis required data on the stock catch/landings–length composition and life-history parameters as Linf.

The length-based indicators analysis was performed using the commercial landings in 2013to 2015 (discards considered negligible) and the following life-history parameters: Linf=74.1.

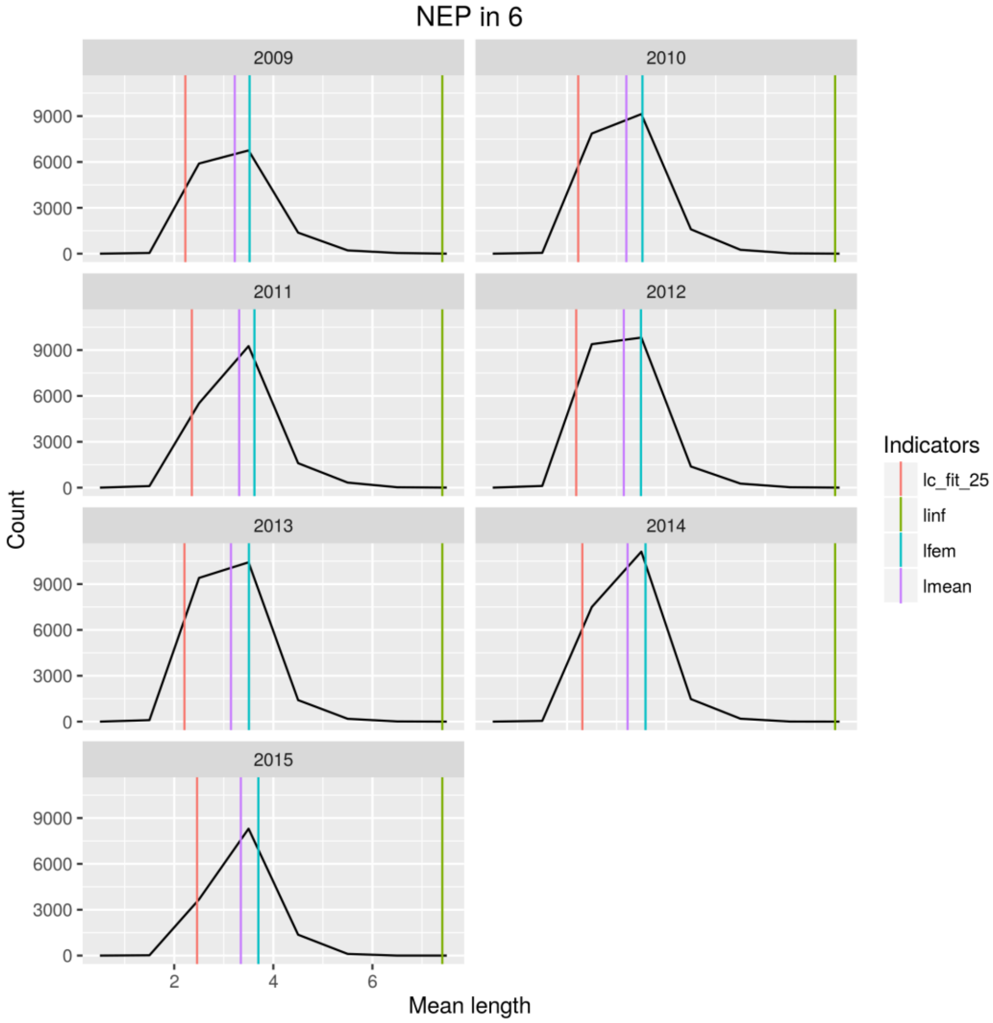


Figure 6.8.2.6. Norway Lobster in GSA 6. Length-based indicators and reference points for Norway lobster using the catch length composition for 2009, to 2015

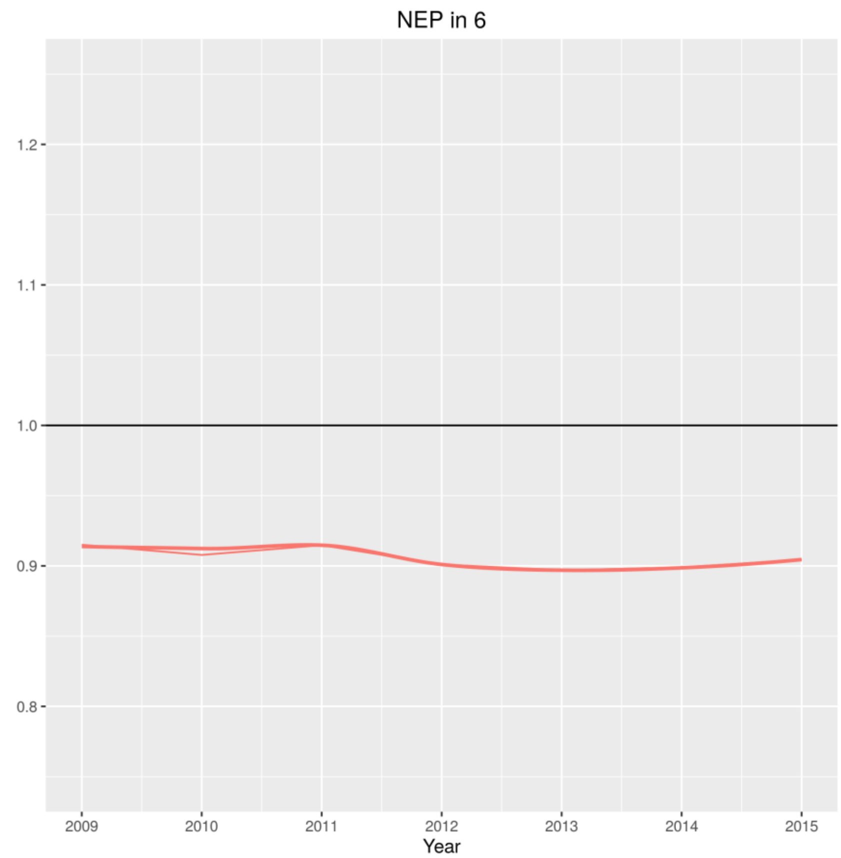


Figure 6.8.2.7. Norway Lobster in GSA 6. Length-based indicator for Norway lobster using the catch length composition for 2009 to 2015

The overall perception from length-based indicators is that the stock is being fished well above the MSY level. Such perception supports the result obtained from XSA and separable VPA assessments. The indicator also supports the view of increasing F over time.

6.8.3 REFERENCE POINT

The converged time series of SSB and R values is not sufficient to allow evaluation of S-R elements of MSY, so the WG has applied the STECF recommended method of F0.1. Stocks produced by XSA runs with different Shrinkages resulted in F0.1(2-6) values ranging from 0.170 to 0.174. The stocks produced by the three optimal separable VPAs had a F0.1(2-6) value of 0.178. Weighting thew two methods (Sep and XSA) equally gives an overall value of F0.1=0.175

While no specific assessment run was considered to produce reliable Fcurr estimates, some clear insights have been gained on the exploitation state of this stock by the different assessments that were carried out. Both the XSA and separable VPA runs showed that F(2-6) in 2013 (F(2-6)=0.8) was more than four times higher than F0.1, and that F has further increased in 2014 and 2015. Also, SSB in both the XSA and separable VPA runs has been clearly decreasing after 2010; SSB in 2015 was found to be 1.7-3.4 times lower than that in 2010, depending on the assessment. Therefore, the stock is considered overexploited and a reduction of F to levels producing maximum long-term yields (0.17-0.18) is required.

6.8.4 SHORT TERM FORECAST

No short-term forecast was carried out for this stock, due to the lack of a reliable tuning index.

6.8.5 QUALITY AND PROPOSALS FOR FUTURE ASSESSMENTS

The main data quality deficiency observed in *N. norvegicus* in GSA 6 was the mismatch between the trends of landings and MEDITS indices, which hindered the production of a reliable XSA assessment. The dramatic drop of the MEDITS abundance and biomass indices in 2014 and 2015 was not observed in the landings. Therefore, the MEDITS data of 2014 and 2015 needs to be revisited, to assess whether the observed drop was an artefact or a real reduction which, for some reason was not observed in the landings. MEDITS data of earlier years (especially 2009, 2012 and 2013) also exhibit some systematic discrepancies with landings.

It was noted that some entries in the MEDITS LFD data were in millimetres instead of centimetres and need to be corrected. These erroneous entries were (by entry id): 3407785-89, 3436154, 3446194-95, 3503235 and 3580944.

MEDITS LFDs of year 2001 had a different range in the length classes compared to the other years (5 mm instead of 1 mm). This discrepancy did not affect the assessments, as these were carried out for 2009-2015.

No data on growth, maturity and sex ratio were available in the DCF for *N. norvegicus* in GSA 6. These should be collected and reported in the future.

Male and female specimens of *N. norvegicus* are known to exhibit different growth patterns. Hence, the provision of sex ratios by length and year in the catches, would allow to carrying out more accurate assessments in the future, whereby sexes would be split.

6.9 NORWAY LOBSTER IN GSA 9

6.9.1 DATA GATHERING OF NORWAY LOBSTER IN GSA 9

6.9.1.1 Stock Identity and Biology

Stock Identification

Due to a lack of information about the structure of *N. norvegicus* population in the western Mediterranean, this stock was assumed to be confined within the GSA 9 boundaries (Figure 6.9.1.1.1).

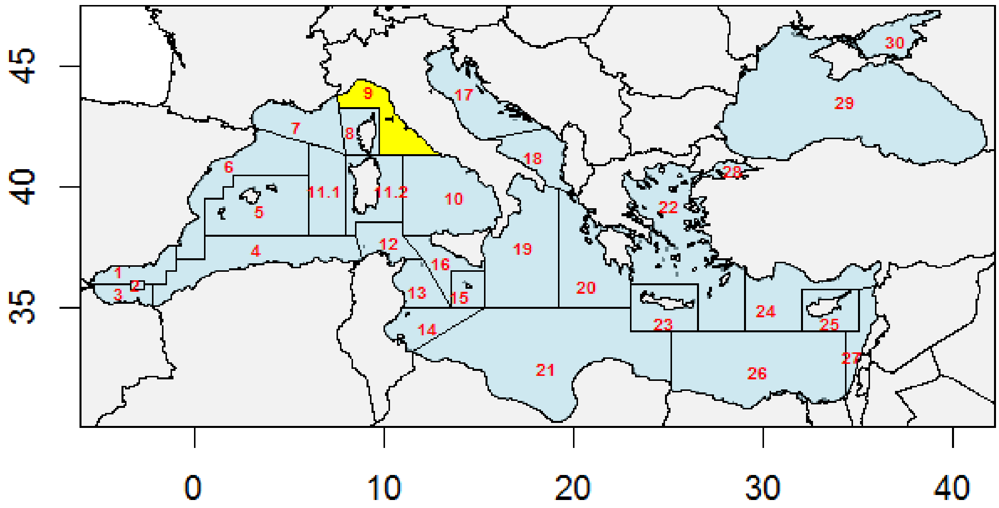


Figure 6.9.1.1.1. Geographical location of GSA 9.

Age and growth
For *N. norvegicus*, there is a difference in growth between males and females. Males grow more slowly and reach a greater size compared to females. Growth parameters for *N. norvegicus* in GSA 9 are provided in Table 6.9.1.1.1. The stock assessment was parametrized with growth parameters to combined sex because of length structure of landings were not separated by sex.

Table 6.9.1.1.1. Norway lobster in GSA 9. Growth parameters (Linf, K, t0) and parameters of the Length-Weight relationship (a, b) used for the assessment of N. norvegicus in GSA 9

Sex	Linf (mm)	K	t0	a	b
M	72.1	0.17	0	0.0003	3.193
F	56	0.21	0	0.0004	3.189
Combined	74.1	0.17	0	0.0001	3.08

Maturity
For *N. norvegicus*, there is a difference in maturity at age between males and females, with the former maturing earlier than the latter. The DCF information on maturity at age of *N. norvegicus* in

GSA 9 was restricted to females (Table 6.9.1.1.2). The present assessment used maturity at age to combined sex as it was used by the assessment held in 2014 (STECF-14-17) (Table 6.9.1.1.2).

Table 6.9.1.1.2. Norway lobster in GSA 9. Maturity at age of N. norvegicus in GSA 9

Sex	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+
F	0.04	0.16	0.43	0.75	0.92	0.98	0.99
Combined	0.1	0.25	0.5	0.8	1.0	1.0	1.0

Feeding and Habitat

N. norvegicus is a mud-burrowing species that prefers sediments with mud mixed with silt and clay in variable proportions. The emergence from burrows of individuals may vary depending on biological features or environmental factors (moult or reproduction cycles, light intensity, etc.). The species lives on muddy substrates at depths between 150 and 800 m, but in the area is more commonly found between 250 and 800 m depth (Biagi *et al.*, 2002; Colloca *et al.*, 2003). Recruits peak in abundance between 400 and 500 m depth over the upper slope and appear to move slightly deeper when they reach 30 mm carapace length. It is an active predator or scavenger, feeding on detritus, crustaceans and worms (Holthuis 1991).

Natural mortality

The natural mortality vector was calculated using Prodbiom (Abella et al. 1997) and it was the same for both sexes (Table 6.9.1.1.2).

Table 6.9.1.1.2. Norway lobster in GSA 9. Natural mortality vector for N. norvegicus in GSA 9 for both males and females.

Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
0.48	0.36	0.3	0.27	0.26	0.24	0.23	0.23

6.9.1.2 Catch data

Landings

Landings of *N. norvegicus* in GSA 9 are almost exclusively provided by trawling. Very low values have been also reported for gillnet and trammel net (Table 6.9.1.2.1). Total landing have shown a persistent decreasing trend, reducing landings from 287.60 (2005) to 113.62 tons (2015) (Figure 6.9.1.2.1). This landing reduction matches with decreasing of fishing effort (kW*Days at sea) (Figure 6.9.1.3.1). Due to number of specimens by length was not reported in the case of the métier “Demersal species” (DWSP), raising of specimens by length was performed to 2005, 2008 and 2010-2015.

Table. **6.9.1.2.1**. Norway lobster in GSA 9. Landings (t) of *N. norvegicus* by fishing technique in GSA9.

Year	OTB	GNS	GTR	Total
2005	287.60	0.40	0.50	288.50
2006	247.39	0.09		247.49
2007	260.55			260.55
2008	227.67	0.05		227.72
2009	250.24		0.04	250.28

2010	161.61	0.01	0.03	161.64
2011	183.92	0.01	0.03	183.96
2012	177.84	0.04	0.30	178.19
2013	147.65			147.65
2014	111.52	0.08		111.60
2015	113.62			113.62

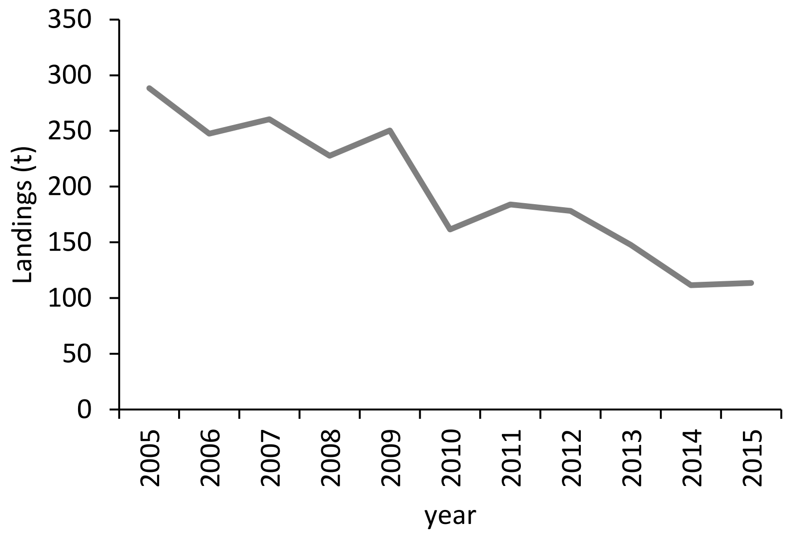


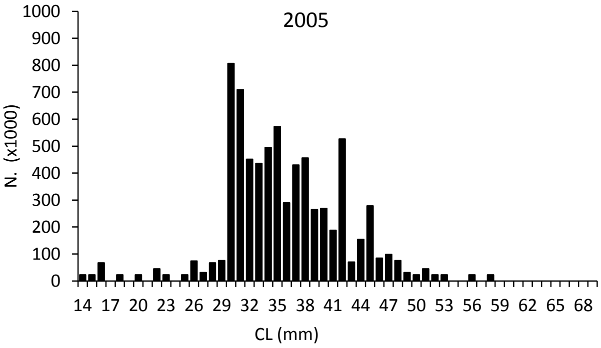
Figure 6.9.1.2.1. Norway lobster in GSA 9. *N. norvegicus* in GSA9. Landings (t) from 2005 to 2015 (DCF official data). Only landings of trawling fleet (OTB) are shown.

Landings are mostly composed by specimens from 25 to 50 mm CL, but length structure looks variable through years (Table 6.9.1.2.2, Figure 6.9.1.2.2). Due to the different growth rates between sexes, the majority of the specimens greater than 40 mm CL are males.

Table 6.9.1.2.2. Norway lobster in GSA 9. Number at length of specimens landed by the trawling fleet in GSA9

Length	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
14	22.40	0.00	4.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	22.40	0.00	4.74	0.00	0.00	0.00	0.00	1.42	0.00	0.00	0.00
16	67.20	0.00	4.74	1.24	0.00	2.07	1.12	0.00	1.75	0.00	0.00
17	0.00	0.00	4.74	5.43	0.00	1.17	0.00	6.61	0.00	1.06	0.00
18	22.40	0.00	6.90	17.02	5.37	3.07	0.00	9.50	2.45	0.00	0.00
19	0.00	0.00	19.74	22.48	10.99	0.95	0.73	25.61	6.75	0.00	0.00
20	22.40	1.21	68.34	23.64	22.05	7.59	5.61	42.70	17.68	0.27	0.37
21	0.00	3.08	76.84	38.07	51.65	34.92	27.16	62.72	46.27	5.99	7.39
22	44.80	6.55	87.21	59.28	163.39	42.31	38.01	82.61	61.93	0.88	3.54
23	22.40	2.76	103.73	88.96	159.47	105.12	94.20	90.49	79.79	3.56	11.14
24	0.00	15.63	118.82	109.44	179.02	90.06	125.61	105.10	98.22	11.93	18.27
25	22.40	20.68	155.89	180.03	252.66	178.13	264.14	135.88	147.77	23.58	27.69
26	73.91	88.11	138.40	237.19	332.32	258.38	362.04	233.91	225.54	46.25	58.25
27	30.98	78.33	181.19	252.12	433.04	282.94	459.40	259.58	240.47	89.93	150.21
28	67.20	277.06	154.08	297.00	405.95	404.60	396.41	361.62	287.12	100.89	126.95

29	75.78	181.91	168.56	422.88	295.06	356.44	432.04	358.07	245.35	108.55	175.04
30	806.69	225.10	237.10	354.49	480.32	394.47	524.44	391.85	303.99	150.48	232.66
31	709.37	206.85	165.42	377.53	386.73	395.54	404.75	417.40	275.13	187.17	294.10
32	451.85	283.30	230.92	379.14	286.97	373.11	409.74	356.16	262.99	188.52	263.38
33	436.01	248.91	382.11	412.69	284.12	356.35	380.74	388.25	263.09	247.37	258.51
34	494.77	187.09	283.10	436.90	394.36	299.92	358.16	303.44	255.70	237.92	210.29
35	572.44	312.07	353.44	351.90	326.28	270.51	362.36	278.44	243.68	201.41	211.53
36	289.93	185.48	301.53	310.64	371.23	266.80	324.62	238.60	262.89	203.80	161.16
37	430.17	405.76	509.46	297.69	268.96	163.71	185.46	209.05	170.61	185.62	147.80
38	456.07	185.47	279.69	223.66	343.50	170.70	177.80	190.75	154.67	160.74	118.94
39	264.79	266.10	222.89	184.91	319.97	179.35	134.81	191.90	145.07	137.46	117.86
40	269.41	415.53	199.44	188.12	224.45	111.29	88.50	168.66	144.22	146.63	92.64
41	188.39	313.39	115.69	143.98	212.52	110.74	98.59	134.31	104.80	115.41	65.36
42	526.88	297.43	316.45	118.30	198.45	80.93	103.78	120.72	113.19	111.18	78.74
43	70.55	113.41	90.55	107.02	146.55	81.05	121.79	102.36	67.61	59.48	60.10
44	154.06	253.87	123.17	83.11	113.11	55.89	64.35	77.18	71.21	57.37	48.89
45	278.14	94.39	137.00	157.31	96.05	53.79	82.49	71.49	64.69	30.61	39.62
46	84.37	186.01	153.08	104.69	90.13	52.48	83.46	67.77	48.94	34.22	27.35
47	98.18	93.38	112.98	81.22	69.07	44.84	50.75	54.37	43.00	29.57	28.68
48	75.78	56.32	161.05	82.49	55.94	44.99	48.81	52.47	57.06	19.12	26.78
49	30.98	38.39	90.72	44.82	60.02	34.61	35.71	47.78	42.33	15.60	18.25
50	22.40	144.81	74.87	43.27	107.10	31.69	31.58	29.65	27.98	23.60	18.25
51	44.80	65.45	165.52	33.38	46.71	26.93	21.42	21.84	22.55	15.13	13.14
52	22.40	20.20	115.40	69.04	19.64	21.60	18.10	22.87	25.89	9.25	19.15
53	22.40	36.05	86.32	66.91	32.17	19.50	22.10	19.25	16.11	11.22	7.86
54	0.00	18.29	20.56	34.34	41.24	10.45	16.60	13.01	16.75	6.81	4.63
55	0.00	0.72	75.90	15.56	24.39	10.80	9.06	14.68	8.56	9.56	14.32
56	22.40	35.57	6.22	20.19	26.27	4.33	6.13	9.45	7.82	9.05	6.04
57	0.00	0.91	5.91	14.87	26.31	3.88	2.33	4.92	3.07	7.08	4.75
58	22.40	34.99	1.06	18.98	3.63	9.05	4.31	3.53	4.75	2.72	3.31
59	0.00	18.18	0.81	10.79	8.62	4.04	1.11	4.55	0.60	4.86	1.37
60	0.00	17.67	1.01	14.51	15.85	2.38	3.31	3.69	2.60	4.49	2.14
61	0.00	54.66	2.07	1.64	1.67	1.34	0.00	1.66	4.28	2.97	2.10
62	0.00	0.00	1.14	2.65	3.63	0.23	0.98	0.62	0.00	1.76	1.14
63	0.00	0.00	0.34	0.00	0.00	0.40	1.36	0.62	0.00	0.92	0.10
64	0.00	0.00	0.34	0.00	1.08	0.00	0.00	0.00	0.00	1.03	0.57
65	0.00	0.00	0.00	0.31	0.00	0.24	0.00	0.00	0.00	3.00	0.00
66	0.00	0.00	0.34	0.00	0.00	0.00	0.17	0.00	0.00	0.85	0.00
67	0.00	0.00	0.00	0.00	11.54	0.00	0.00	0.00	0.00	0.08	0.00
68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08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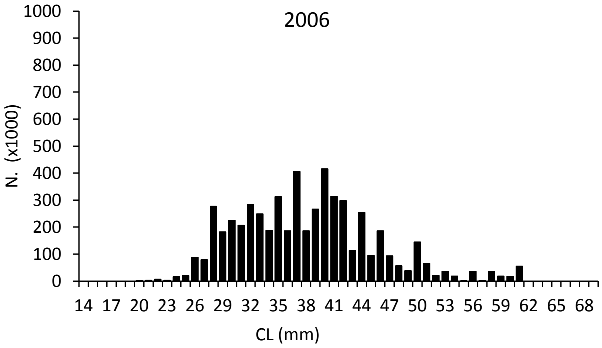
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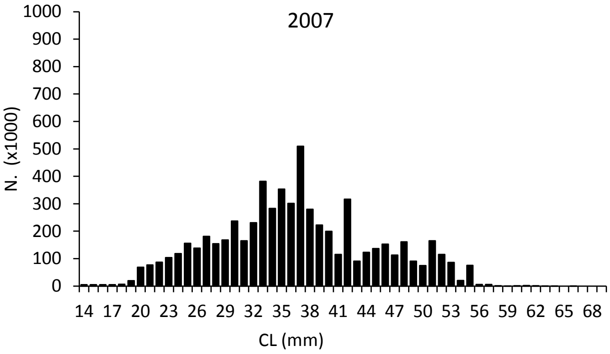
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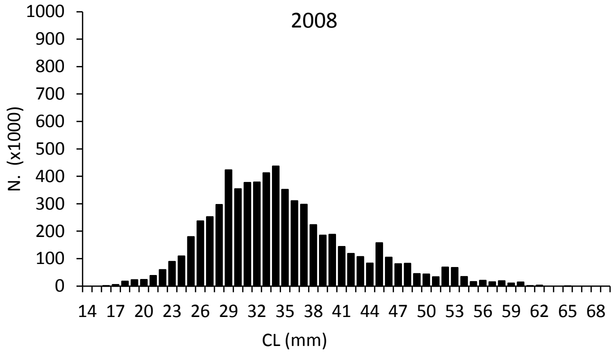
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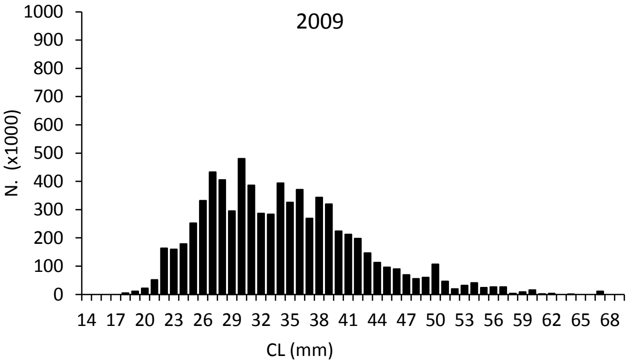
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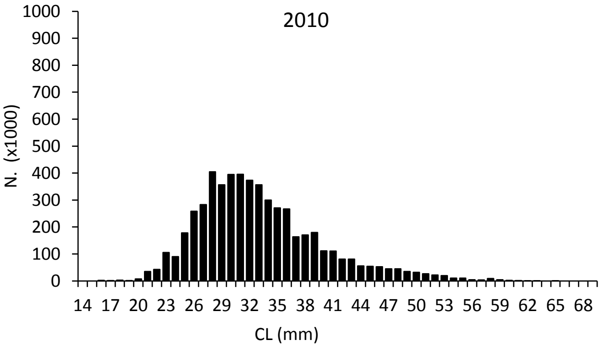
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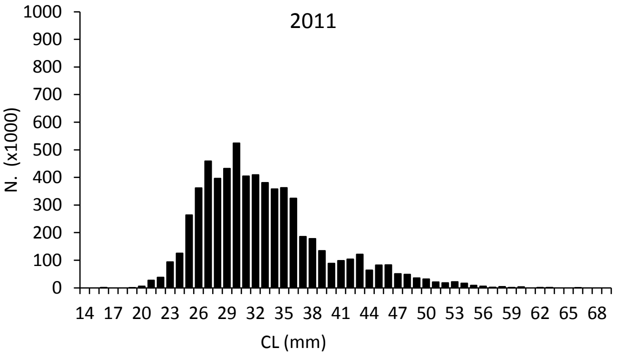
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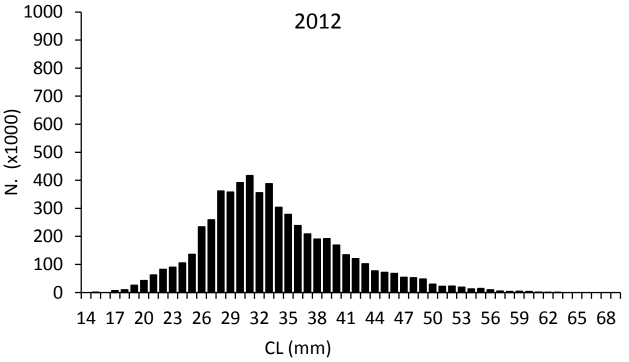
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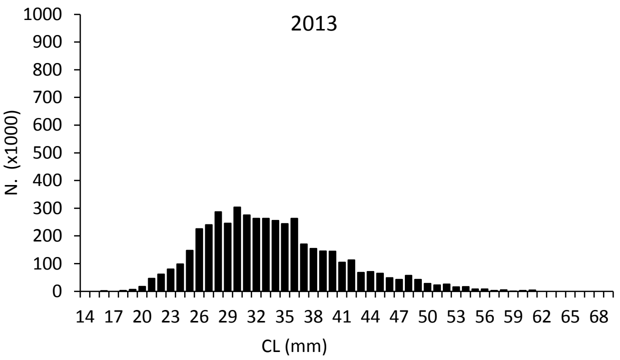
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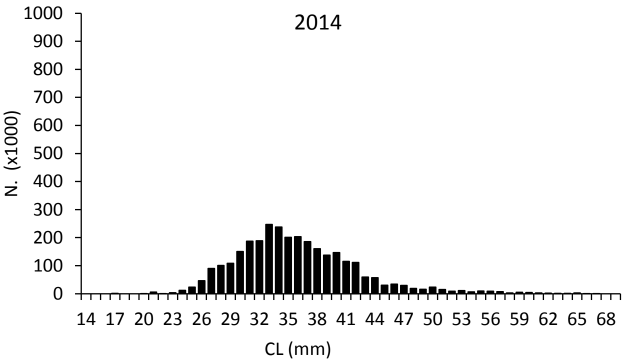
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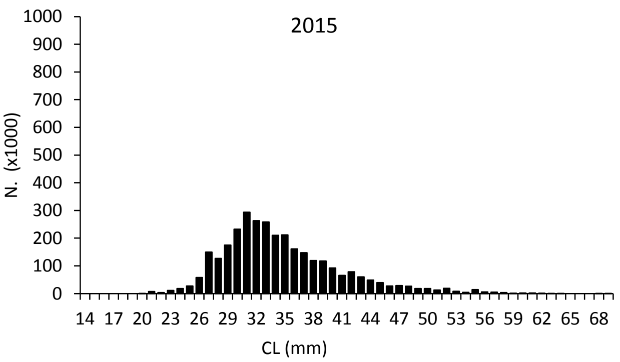
CL (mm)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CL (mm)

Figure 6.9.1.2.2. Norway lobster in GSA 9. Length structure of specimens landed by the trawling fleet in GSA9

By checking the sum of products (SoP) of numbers and individual weight with reported landing the small number of individuals at length by metier were missing due to an absence of sample data for OTB DEMSP (2005) and OTB DWSP for the years between 2008 and 2015. To correct these SoP errors raising factors were applied to the numbers at age so the SoP matched the reported landings (Table 6.9.1.2.2b).

Table 6.9.1.2.2b. Norway lobster in GSA 9. Raising applied to landings.

Year	Métier	Raising
2005	DEMSP	4.93%
2008	DWSP	0.26%
2010	DWSP	1.74%
2011	DWSP	1.92%
2012	DWSP	1.47%
2013	DWSP	1.48%
2014	DWSP	1.49%
2015	DWSP	1.35%

Discards

Discards of *N. norvegicus* in GSA9 are reported since 2009 (Table 6.9.1.2.3), varying from 0.41 (2014) to 9.24 (2009) tons. Discards are mostly composed by specimens from 14 to 25 mm CL (Table 6.9.1.2.4 and Figure 6.9.1.2.3). Given that discards are not reported since 2005 as well as discards are minimal in most years, they were considered negligible and were not involved in the assessment.

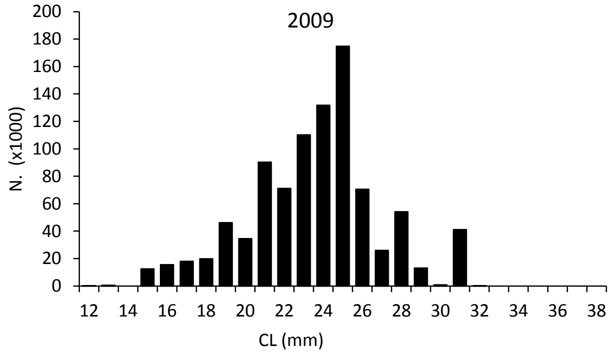
Table 6.9.1.2.3. Norway lobster in GSA 9. Discards (t) by trawling fleet (OTB) in GSA9

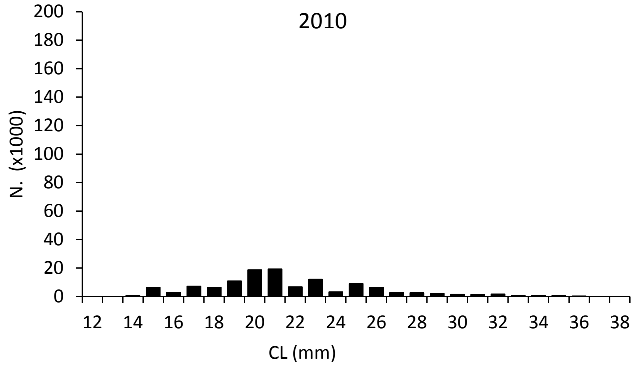
Year	Discards
2009	9.24
2010	1.00
2011	1.02
2012	0.78
2013	1.31
2014	0.41
2015	0.10

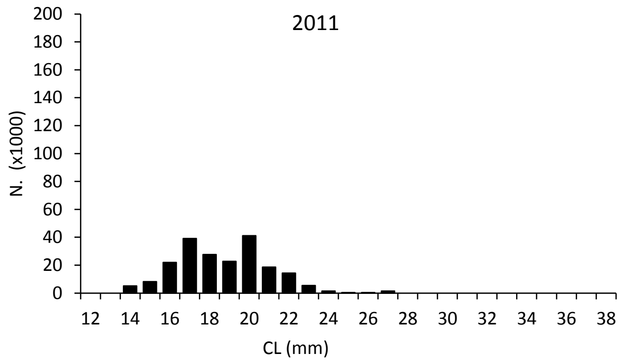
Table 6.9.1.2.4. Norway lobster in GSA 9. Number at length of specimens discarded by the trawling fleet in GSA9

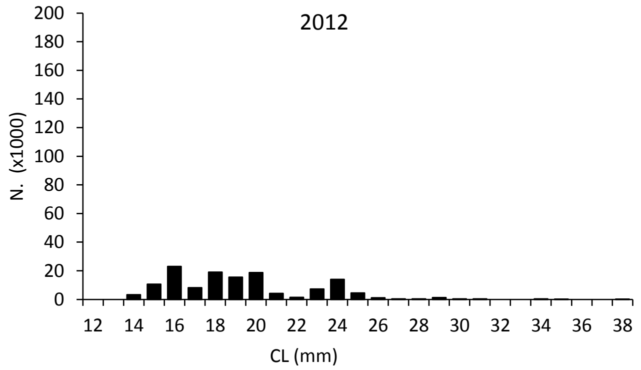
length	2009	2010	2011	2012	2013	2014	2015

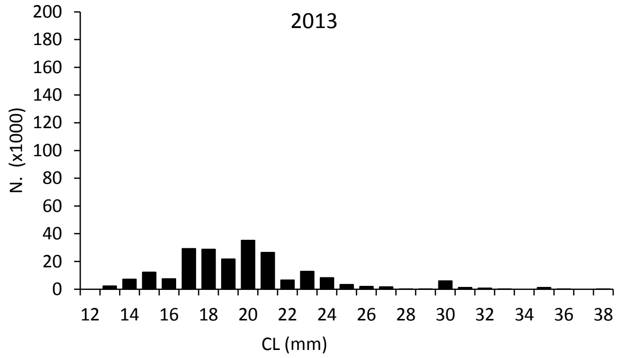
12	0.278	0.000	0.000	0.000	0.000	0.000	0.672
13	0.556	0.000	0.000	0.000	2.292	0.000	0.000
14	0.000	0.759	5.171	3.346	7.192	0.000	0.000
15	12.531	6.350	8.217	10.659	12.187	0.000	0.000
16	15.547	2.812	22.018	23.035	7.465	0.000	0.418
17	18.051	7.131	39.082	8.172	29.203	0.328	2.926
18	19.807	6.443	27.687	19.142	28.677	3.925	1.090
19	46.212	10.802	22.760	15.569	21.659	3.925	2.180
20	34.521	18.633	41.085	18.863	35.111	4.405	0.836
21	90.347	19.228	18.686	4.175	26.493	9.317	3.360
22	71.134	6.643	14.331	1.450	6.460	3.677	1.508
23	110.285	11.994	5.469	7.313	12.749	8.267	2.858
24	131.849	3.134	1.429	14.108	8.286	8.082	0.672
25	174.758	8.948	0.439	4.610	3.244	4.885	0.000
26	70.531	6.347	0.439	1.130	1.925	0.000	0.000
27	25.985	2.717	1.429	0.414	1.584	0.000	0.000
28	54.232	2.505	0.000	0.414	0.159	0.000	0.000
29	13.088	2.120	0.000	1.337	0.159	0.000	0.000
30	0.835	1.558	0.000	0.414	5.905	2.442	0.000
31	41.144	1.380	0.000	0.414	1.246	0.000	0.000
32	0.278	1.635	0.000	0.000	0.712	0.000	0.000
33	0.000	0.562	0.000	0.000	0.159	0.000	0.000
34	0.000	0.536	0.000	0.414	0.000	0.000	0.000
35	0.000	0.536	0.000	0.207	1.105	0.000	0.000
36	0.000	0.255	0.000	0.000	0.159	0.000	0.000
37	0.000	0.000	0.000	0.000	0.000	0.000	0.000
38	0.000	0.000	0.000	0.207	0.159	0.000	0.000

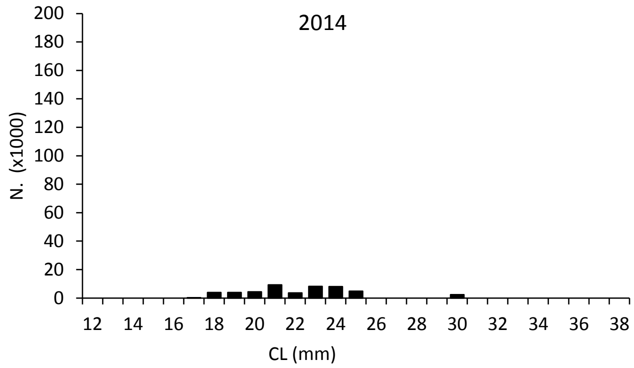

2009
N. (x1000)
CL (mm)


2010
N. (x1000)
CL (mm)


2011
N. (x1000)
CL (mm)


2012
N. (x1000)
CL (mm)





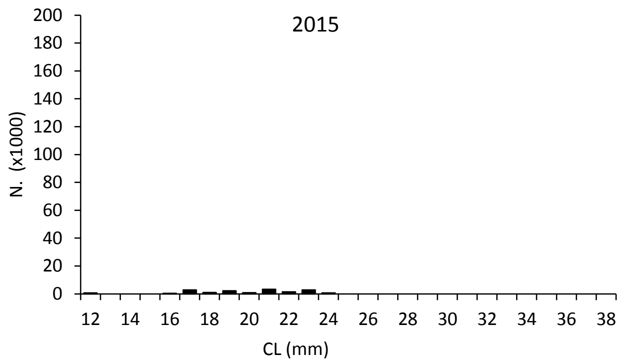


Figure 6.9.1.2.3. Norway lobster in GSA 9. Length structure of specimens discarded by the trawling fleet in GSA 9

6.9.1.3 Fishing effort data

The number of OTB vessels exhibited an increasing trend in 2004-2010 followed by a decreasing trend in 2010-2015, while OTB days at sea have not exhibited any particular trend (Table 6.9.1.3.1; Figure 6.9.1.3.1.a-b). Nominal effort (kW*Days at sea) of OTB decreased in 2004-2012, but has slightly increased in the past three years of the time-series (Figure 6.9.1.3.1c). The OTB LPUE has a greater decreasing trend than nominal effort (Figure 6.9.1.3.2).

Table 6.9.1.3.1. Norway lobster in GSA 9. OTB effort in GSA 9

Year	Number of vessels	Days at sea	kW*Days at sea
2004	1460	368389	14820339
2005	1450	323405	14700599
2006	1316	304544	12404787
2007	1564	289865	12782144
2008	1698	280173	10775882
2009	1697	310149	12172751

2010	2183	291989	11228001
2011	1710	316537	10696166
2012	1727	278708	9997907
2013	1593	281610	10724881
2014	1357	286846	10975696
2015	1321	374989	11095335

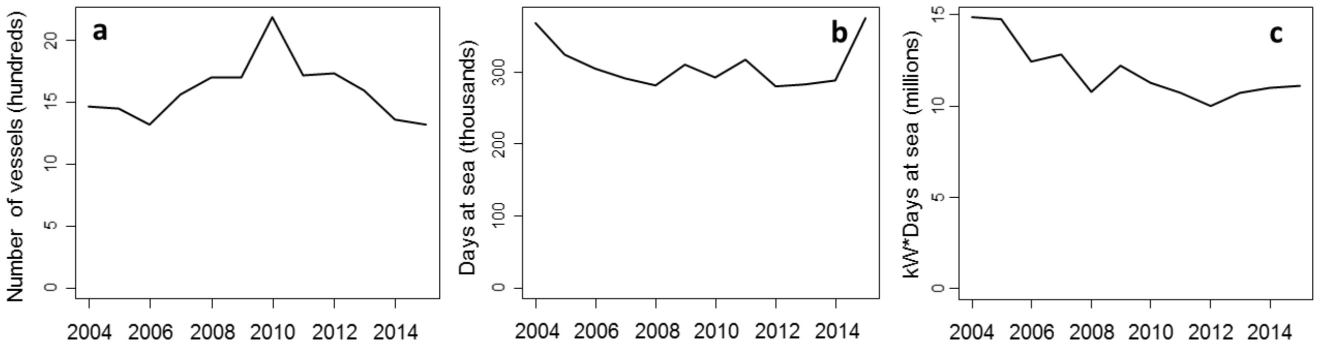


Figure 6.9.1.3.1. Norway lobster in GSA 9. Temporal development of OTB fishing effort in GSA 9 in 2004-2015 in terms of number of vessels (a), days at sea (b), and kW*Days at sea (c).

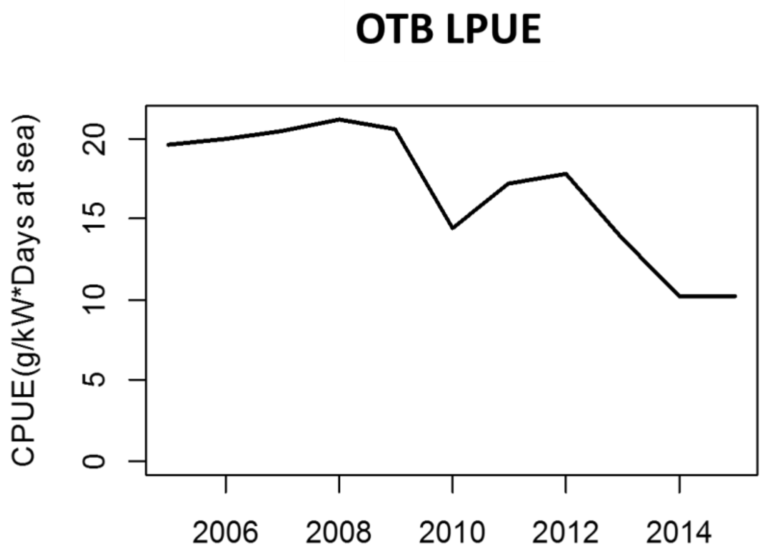


Figure 6.9.1.3.2. Norway lobster in GSA 9. Temporal development of OTB LPUE for *N. norvegicus* in GSA9 during 2005-2015

6.9.1.4 Survey Indices of abundance and biomass by year and size/age

The abundance (n/km^2) and biomass (kg/km^2) indices obtained for *N. norvergicus* in GSA 9 by means of the MEDITS surveys were computed based on the DCF data call 2016. The number of hauls in that stratum along the 22 year time series is shown in the following table:

Table 6.9.1.4.1. Norway lobster in GSA 9. MEDITS survey. Number of hauls per year and depth stratum in GSA 9, 1994-2015.

Stratum	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
0-50	21	20	20	20	21	20	20	20	15	15	15
50-100	21	21	20	20	20	21	21	22	17	17	17
100-200	38	39	40	39	39	39	39	38	30	30	30
200-500	39	39	40	42	39	41	42	41	32	30	33
500-850	34	34	33	32	34	32	31	32	26	28	25
Total	153	153	153	153	153	153	153	153	120	120	120
Stratum	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
0-50	15	15	15	15	16	15	15	15	15	15	14
50-100	17	18	16	17	15	17	17	17	18	18	19
100-200	31	29	31	31	32	31	31	31	30	30	30
200-500	34	35	35	33	33	34	33	35	33	36	35
500-850	23	23	23	24	24	23	24	22	24	21	22
Total	120	120	120	120	120	120	120	120	120	120	120

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Few obvious data errors were corrected. Catches by haul were standardized to 60 minutes hauling duration. The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Yst = \Sigma (Yi*Ai) / A$$
$$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$$

Where:
A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± t(student distribution) * V(Yst) / n

It was noted that while this is a standard approach, the calculation may be biased due to a number of different factors including the change in the number of hauls over time, and change of the survey time over the years. Precision may also be affected by the choice of parametric distribution, a normal distribution is often assumed, whereas data may be better described by a delta-distribution, quasi-Poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien *et al.* 2004).

Since 2009, both biomass and abundance index have tend to decrease (Table 6.9.1.4.2; Figure 6.9.1.4.1). During same period, the most recorded sizes have been around 30 cm (Figure 6.9.1.4.2).

Table 6.9.1.4.2. Norway lobster in GSA 9. Biomass and density index for N. norvegicus in GSA9 based on MEDITS data. Dashed lines indicate 95% confidence intervals.

Year	Biomass index (kg/km^2)	Density index (n/km^2)
1994	3.41	90.57
1995	3.65	107.66
1996	5.36	156.02
1997	4.50	123.52
1998	6.06	170.65
1999	4.46	126.08
2000	5.62	179.43
2001	6.20	204.35
2002	3.75	110.50
2003	5.49	179.00
2004	4.45	134.70
2005	3.46	116.75
2006	4.97	148.12
2007	5.41	196.94
2008	5.62	187.44
2009	7.25	258.29
2010	5.46	178.15
2011	4.44	132.20
2012	5.44	184.83
2013	3.15	97.30
2014	4.15	144.94
2015	4.42	141.07

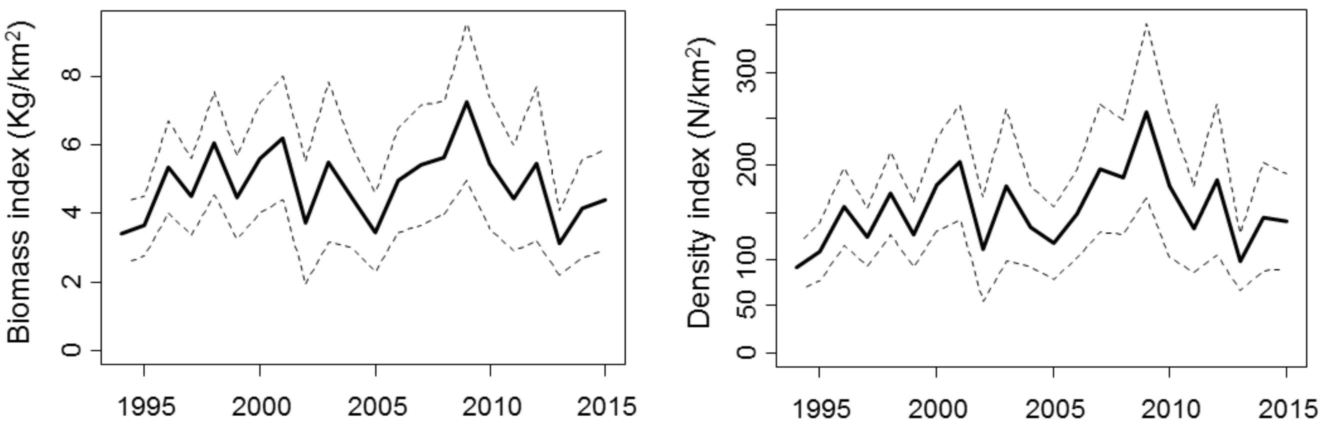


Figure 6.9.1.4.1. Norway lobster in GSA 9. Biomass and density index for N. norvegicus in GSA 9 based on MEDITS data. Dashed lines indicate 95% confidence intervals.

Figure 6.9.1.4.2. Norway lobster in GSA 9. Stratified abundance indices by size and sex for *N. norvegicus* in GSA 9 based on MEDITS data.

6.9.2 STOCK ASSESSMENT ON NORWAY LOBSTER IN GSA 9

Method XSA

An assessment using XSA was performed using DCF data of landings, catch, landings at length, catch and age, biological parameters and MEDITS as input from 2005-2015. Natural mortality-at-age was estimated by PRODBIOM (indirect estimator) from growth parameters and length-weight relationship provided by DCF. The vector of mortality was obtained from the STECF-14-17 report. The analyses were made using R software and the FLR libraries with scripts provided by JRC.

Table 6.9.2.1. Norway lobster in GSA 9. Catch in numbers (10^3) by age and year used in XSA

Year	1	2	3	4	5	6	7+
2005	156.8	307.4	3663.5	1962.3	925.5	215	109.4
2006	2.3	600.8	1639.3	1795.4	853.1	333.9	266.2
2007	141.4	1090.4	1887.7	1595.6	727.6	488.9	390.7
2008	83.4	1503.6	2654.3	1225.8	550.6	239.5	284.6
2009	56.9	2137	2483.6	1617.9	585.5	291.9	236.7
2010	27.3	1599	2380.6	888	306.5	154.1	100.2
2011	17.2	2017.9	2793.3	872.6	430.7	159.5	95
2012	108.3	1525.5	2411.1	1051.5	408.4	175.8	108.5
2013	45.2	1318.6	1849.1	883.6	333.5	166.6	100.4
2014	3.5	346.4	1370	883.2	256.4	85.1	82.4
2015	3	506.4	1630.1	647.3	231.9	88.4	73.5

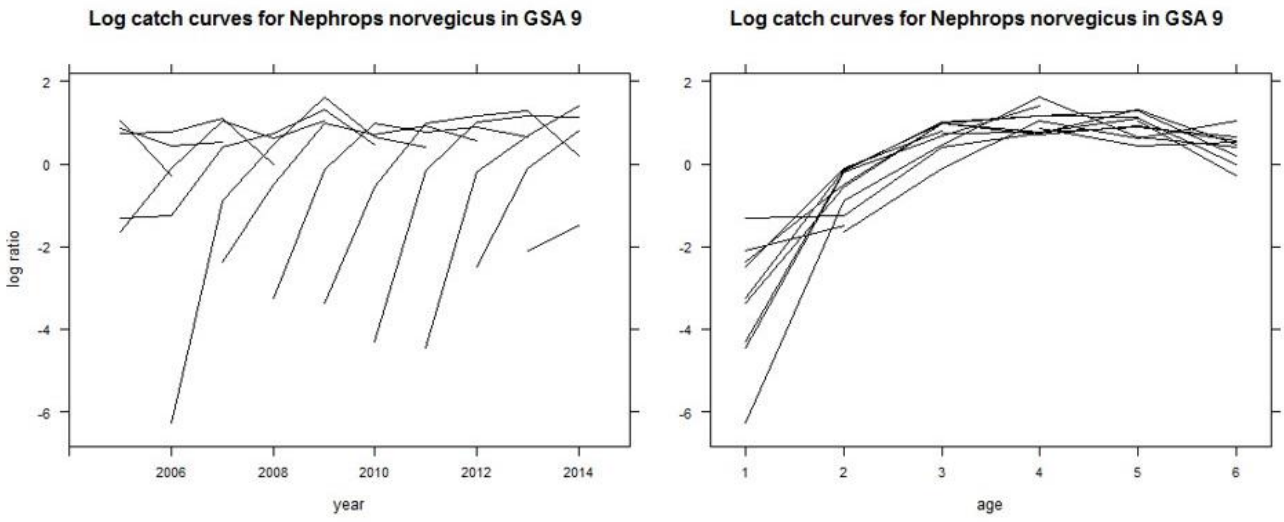


Figure 6.9.2.1. Norway lobster in GSA 9. Log-catch curves.

Table 6.9.2.2. Norway lobster in GSA 9. Mean weights at age used in the XSA (both in catch and stock).

Year	1	2	3	4	5	6	7+
2005	0.006	0.015	0.027	0.042	0.059	0.082	0.129
2006	0.006	0.015	0.027	0.042	0.059	0.082	0.129
2007	0.004	0.010	0.024	0.035	0.051	0.073	0.099
2008	0.004	0.012	0.021	0.034	0.051	0.071	0.112
2009	0.005	0.012	0.023	0.035	0.046	0.064	0.102
2010	0.004	0.012	0.021	0.031	0.045	0.068	0.099
2011	0.005	0.012	0.020	0.031	0.047	0.069	0.098
2012	0.005	0.012	0.021	0.033	0.047	0.066	0.097
2013	0.005	0.011	0.021	0.033	0.048	0.069	0.106
2014	0.004	0.013	0.021	0.031	0.044	0.060	0.101
2015	0.006	0.013	0.023	0.034	0.051	0.072	0.110

Table 6.9.2.3. Norway lobster in GSA 9. Tuning index (MEDITS), estimated number of individuals per km^2.

Year	1	2	3	4	5	6	7+
2005	3.007	25.603	49.522	23.69	10.423	2.537	1.893
2006	0.985	21.362	66.312	36.553	14.644	5.525	2.661
2007	4.003	53.305	86.971	32.086	12.944	4.479	3.15
2008	2.097	41.551	77.775	42.214	15.518	5.226	3.064
2009	4.181	64.236	111.452	50.486	18.711	6.094	3.071
2010	2.551	37.754	76.307	40.194	12.45	4.179	4.712
2011	1.564	19.958	58.636	30.847	12.469	5.275	3.014
2012	5.12	39.51	79.174	36.93	13.003	5.99	3.407
2013	4.32	19.498	36.926	21.486	8.207	3.991	2.869
2014	1.667	41.766	59.506	26.258	9.019	4.376	2.349
2015	2.126	33.775	59.682	27.683	9.488	5.749	2.571

Sensitivity analysis

A sensitivity analysis considering different weight and ages for shrinkage as well as different combinations of qage and rage was performed before running the final XSA (Figure 6.9.2.2). Additional effect of qage in distribution of F at age was explored (Figure 6.9.2.3). According to all sensitivity analyses the best model fit was found using the parameterization below:

Settings of XSA final run

Period: 2005-2015
Age 7+ group was used as input.
Catchability analysis:
Catchability dependent on stock size for ages = 1
Catchability independent of age for ages >= 5
Survivor estimates shrunk towards the mean F of the final 4 years or the 4 oldest ages. S.E. of the mean to which the estimates are shrunk = 1.0

Residuals from tuning fleets (MEDITS) per age and year were relatively low, ranging from 1 to - 1, and did not show any trend with time (Table 6.9.2.3; Figure 6.9.2.4).

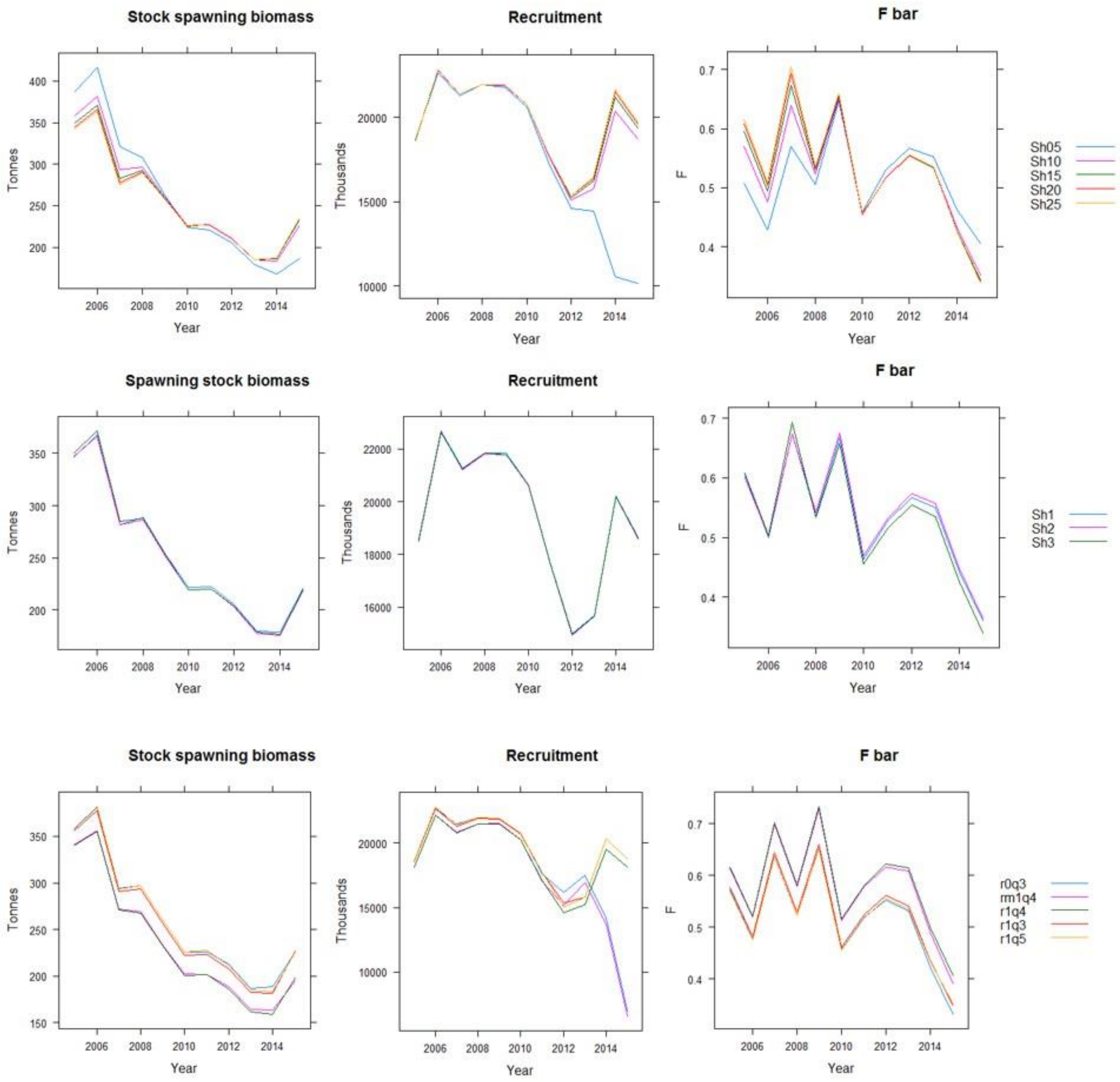


Figure 6.9.2.2. Norway lobster in GSA 9. Estimates of SSB, recruitment and Fbar (2-6) with different shrinkage settings.

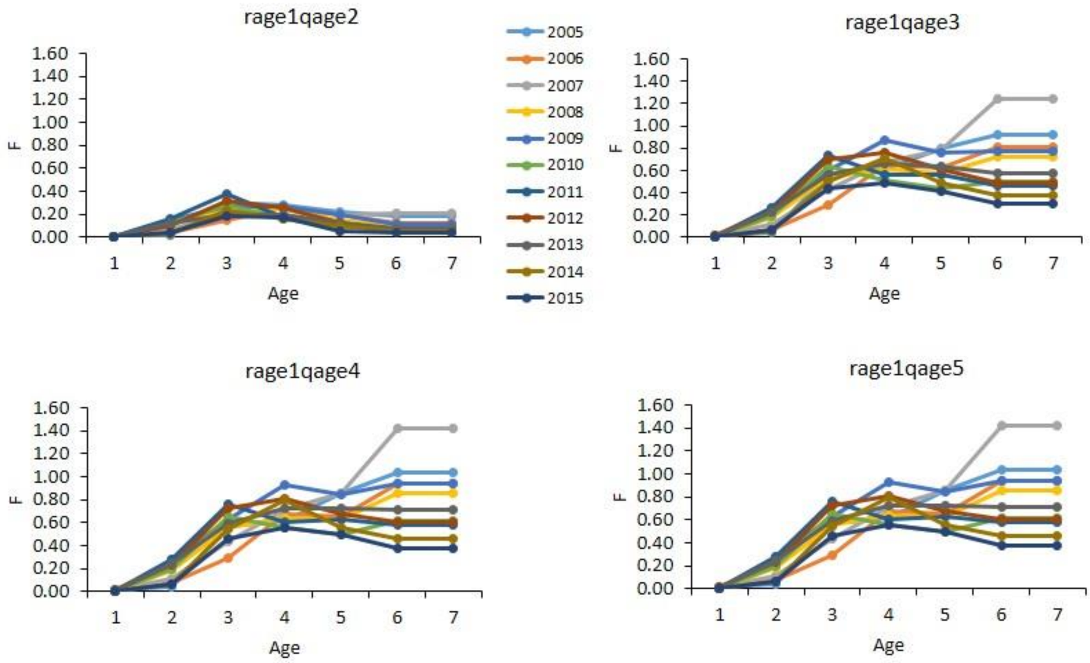


Figure 6.9.2.3. Norway lobster in GSA 9. F-at-age distribution regarding qage value.

Table 6.9.2.3. Norway lobster in GSA 9. Log catchability residuals by age and year (Sh1.0).

age	1	2	3	4	5	6
2005	0.0245	-0.3227	-0.6384	-0.7883	-0.3768	-0.1753
2006	-0.1978	-0.4675	-0.2432	-0.1711	-0.2174	0.0088
2007	0.1834	0.2662	0.1643	-0.2620	-0.0353	-0.1177
2008	0.0054	0.1354	-0.0345	0.1428	0.0509	0.0212
2009	0.2070	0.5965	0.5057	0.4431	0.4662	0.0565
2010	0.0320	0.0224	0.1989	0.1724	0.0353	-0.2307
2011	-0.1965	-0.5122	-0.0545	0.0254	-0.0250	-0.1477
2012	0.0695	0.2963	0.3425	0.3798	0.1831	-0.0233
2013	0.0499	-0.2374	-0.3979	-0.1416	-0.0280	-0.1910
2014	-0.1039	0.3362	0.2247	0.0751	-0.0426	0.0218
2015	-0.0735	-0.1132	-0.0676	0.1243	-0.0105	0.0958

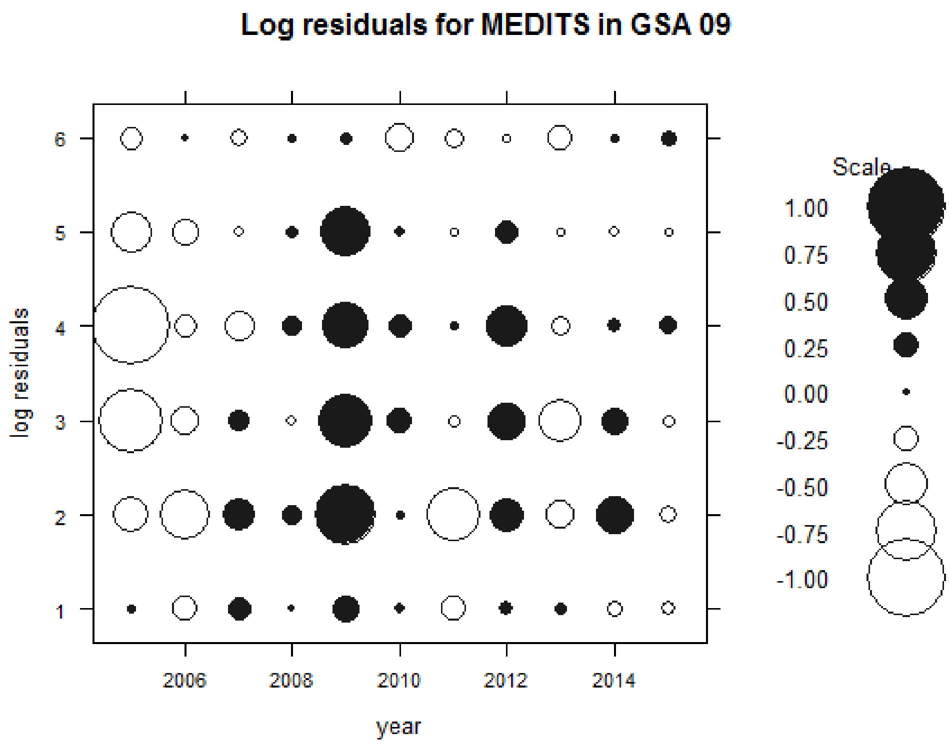


Figure 6.9.2.4. Norway lobster in GSA 9. Bubble plot of residuals of model Sh1.0.

Results

Table 6.9.2.4. Norway lobster in GSA 9. Fishing mortality estimates.

age	1	2	3	4	5	6	7+	Fbar(2-6)
2005	0.011	0.034	0.557	0.604	0.783	0.892	0.892	0.574
2006	0.000	0.067	0.287	0.642	0.614	0.770	0.770	0.476
2007	0.010	0.113	0.416	0.667	0.772	1.223	1.223	0.638
2008	0.006	0.176	0.530	0.603	0.568	0.694	0.694	0.514
2009	0.004	0.255	0.592	0.853	0.736	0.749	0.749	0.637
2010	0.002	0.191	0.625	0.505	0.420	0.478	0.478	0.444
2011	0.002	0.266	0.728	0.557	0.544	0.434	0.434	0.506
2012	0.011	0.226	0.687	0.748	0.591	0.465	0.465	0.543
2013	0.004	0.231	0.556	0.656	0.615	0.548	0.548	0.521
2014	0.000	0.056	0.515	0.704	0.470	0.353	0.353	0.420
2015	0.000	0.061	0.437	0.508	0.399	0.288	0.288	0.339

Table 6.9.2.5. Norway lobster in GSA 9. Stock in numbers (thousands) estimated by age and year.

Age	1	2	3	4	5	6	7+
2005	18753.4	11630	10496.5	5214.54	2043.41	432.49	215.74
2006	22952.53	11474.46	7843.71	4456.96	2176.01	720.15	564.14
2007	21512.98	14200.78	7489.78	4360.86	1790.38	908.04	706.96
2008	22073.08	13182.55	8848.63	3659.54	1708.14	637.66	745.64

2009	21994.81	13580.97	7713.72	3856.78	1528.59	746	594.63
2010	20863.86	13556.55	7342.39	3160.35	1255.2	564.34	362.61
2011	17884.55	12883.72	7810.55	2911.83	1455.48	635.83	374.56
2012	15254.9	11049.82	6890.89	2793.9	1273.94	651.55	397.47
2013	16179.97	9335.35	6151.78	2568.38	1009.89	543.95	323.49
2014	20493.36	9968.46	5167.61	2613.15	1017.56	420.94	403.76
2015	18985.94	12677.36	6576.82	2288.01	986.86	490.51	404.53

Table 6.9.2.6. Norway lobster in GSA 9. XSA summary table.

Year	Landings (t)	Recruits (Age 1)	Biomass (t)	Stock number	SSB (t)	Fbar(2-6)
2005	287.6	18753	973.24	48786	357.73	0.574
2006	247.39	22953	969.02	50188	382.16	0.476
2007	260.55	21513	788.03	50970	294.22	0.638
2008	227.67	22073	772.63	50855	301.43	0.514
2009	250.24	21995	764.06	50016	266	0.637
2010	161.61	20864	629.05	47105	231.37	0.444
2011	183.92	17885	639.49	43957	233.2	0.506
2012	177.84	15255	587.21	38312	215.81	0.543
2013	147.65	16180	517.83	36113	190.08	0.521
2014	111.52	20493	511.9	40085	189.01	0.420
2015	113.62	18986	637.93	42410	234.52	0.339

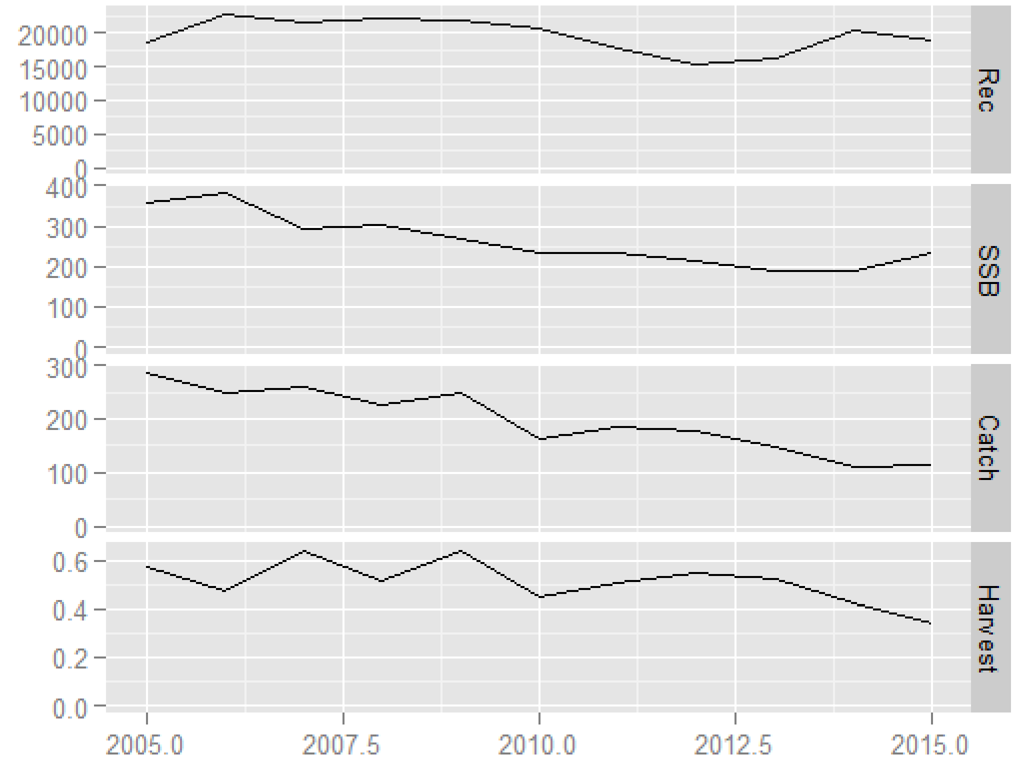


Figure 6.9.2.5. Norway lobster in GSA 9. XSA summary results. SSB and catch are in tonnes, recruitment in 1000s individuals.

A retrospective analysis conducted on SSB, F and recruitment shows that the results of the final XSA estimates are rather robust (Figure 6.9.2.6).

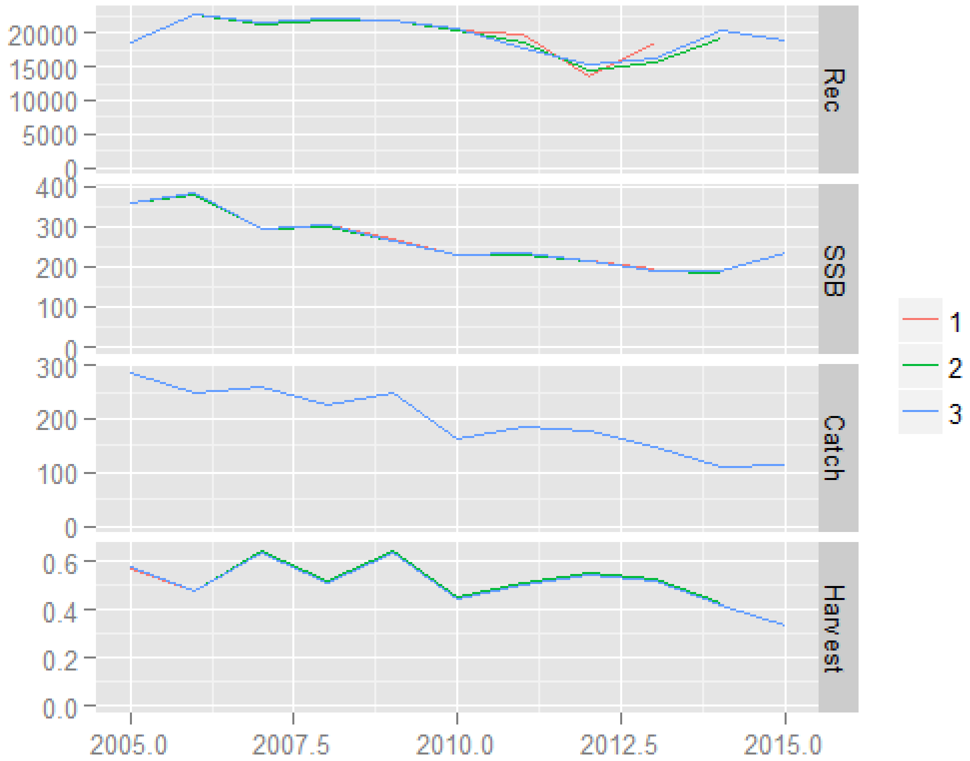


Figure 6.9.2.6. Norway lobster in GSA 9. Results of the retrospective analysis.

Method 2. Length-based analysis

Length-based methods were used for deriving some indicators explored in WKLIFE IV .(ICES, 2015). They allow classifying the stocks according to conservation/sustainability, yield optimization and MSY considerations. Analysis required data on the stock catch/landings–length composition and life-history parameters as Linf.
The length-based indicators analysis was performed using the commercial landings in 2013to 2015 (discards considered negligible) and the following life-history parameters: : Linf=74.1

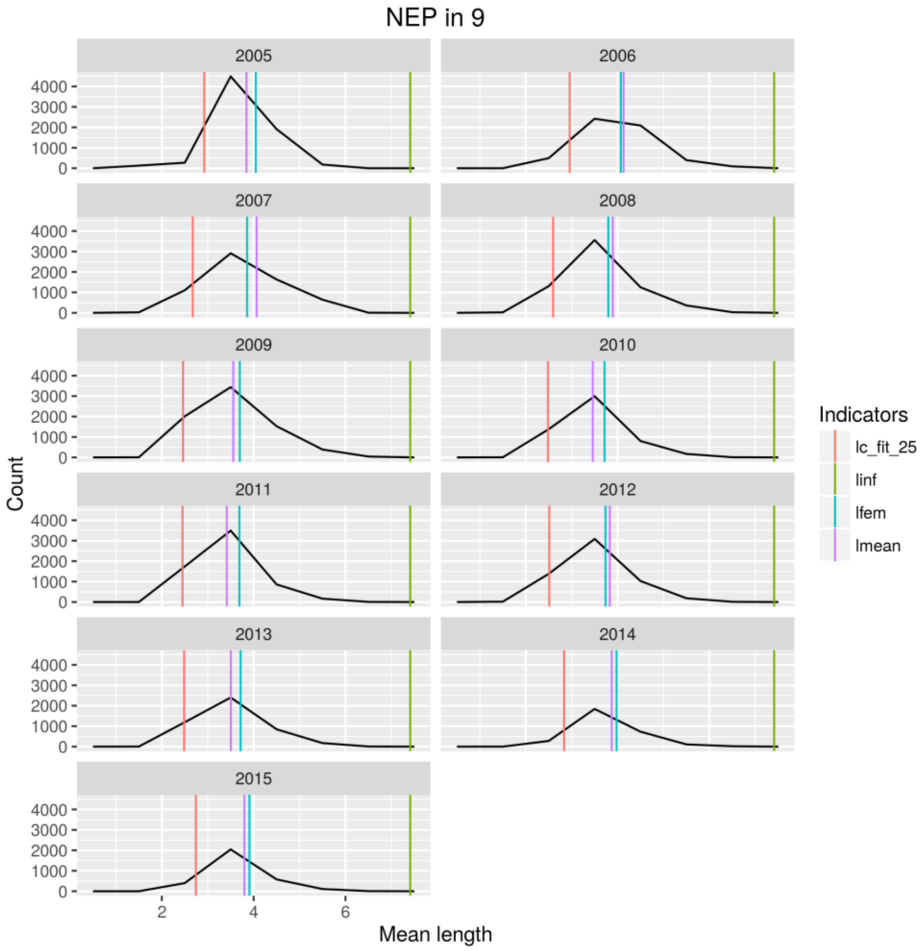


Figure 6.8.2.6. Norway Lobster in GSA 6. Length-based indicators and reference points for Norway lobster using the catch length composition for 2005, to 2015

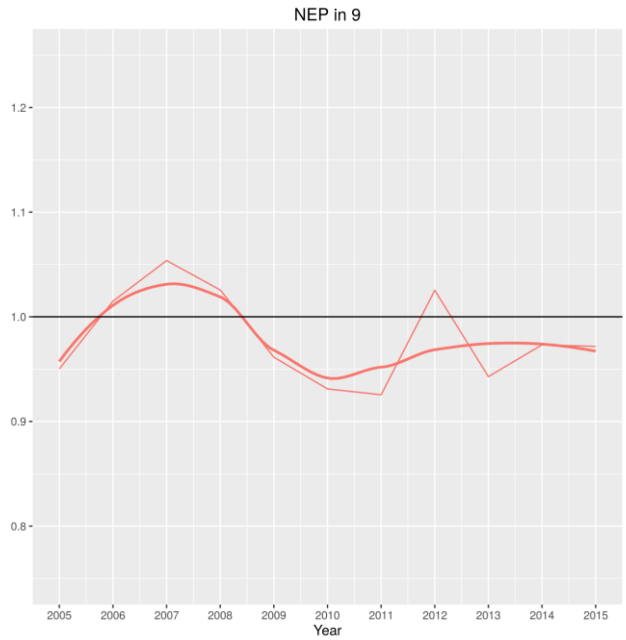


Figure 6.8.2.7. Norway Lobster in GSA 9. Length-based indicator for Norway lobster using the catch length composition for 2009 to 2015

The overall perception from length-based indicators is that the stock is currently being fished above the MSY level. Such a perception supports the result obtained from XSA assessment, though the length indicator does not show the decrease in F in the last few years. Compared with Nephrops in GSA 6 the length indicator for this Nephrops stock suggests F is closer to FMSY than is the case for Nephrops in GSA 6, which is also the conclusion of this XSA assessment.

6.9.3 REFERENCE POINT

The time series of SSB and R values is not sufficient to allow evaluation of S-R elements of MSY, so the WG has applied the STECF recommended method of F0.1. The yield per recruit (YpR) analysis was run using FLBRP routine. Yield per recruit analysis (YPR) was conducted assuming equilibrium conditions, based on the exploitation pattern resulting from the XSA analysis. YPR was used for the estimation of F0.1 (i.e. proxy of FMSY) and Fmax.

The exploitation rate trend was constructed using F0.1=0.194 as a reference point (Table 6.9.3.1; Figure 6.9.3.2). Results also indicate decreasing of Fbar in recent years. However, Exploitation rate values are still estimated to be above the reference point, which indicates over exploitation.

Table 6.9.3.1. Norway lobster in GSA 9. Comparison of estimated values of F0.1, Fmax and Fcurrent using XSA.

F0.1	0.194
Fmax	0.374
Fcurrent (2-6)	0.339

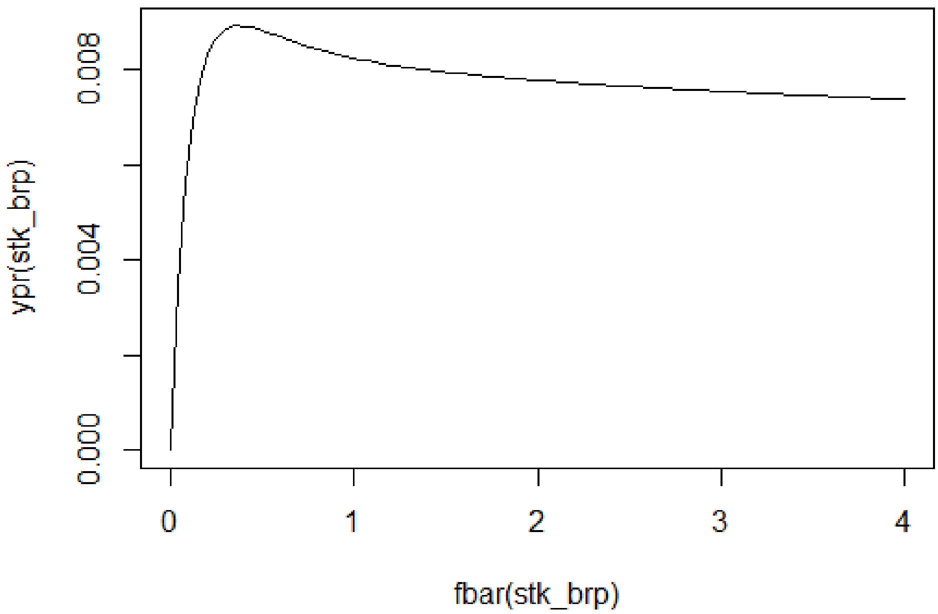


Figure 6.9.3.1. Norway lobster in GSA 9. Results of the YPR analysis.

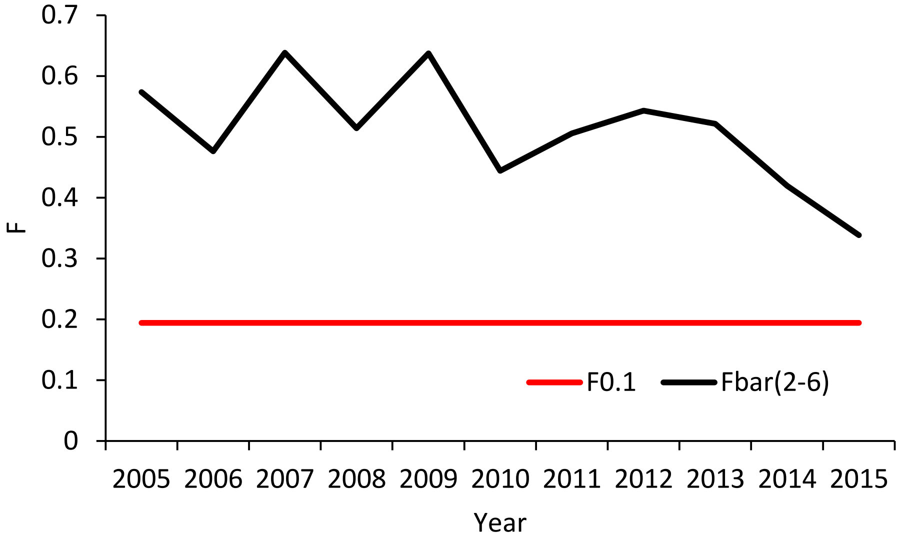


Figure 6.9.3.2. Norway lobster in GSA 9. Estimated values of FMSY and Fcurrent using XSA.

6.9.4 SHORT TERM FORECAST

A short term forecast was produced using the FLR script provided by JRC. Input parameters are the output of the XSA stock assessment, with FMSY set as 0.194 from the yield-per recruit analysis in section 6.9.3.

Table 6.9.4.1. Norway lobster in GSA 9. Short term forecast in different F scenarios. Basis: F(2016) = mean (Fbar 2-6 2013-2015)= 0.46; R(2016) = geometric mean of the recruitment of the last 3 years; R = 18553 thousands; SSB(2015) = 234.52 t, Catch (2015)= 113.62 t.

	Ffactor	Fbar	Catch 2017	Catch 2018	SSB 2017	SSB 2018	Change_SSB 2017-2018(%)	Change_Catch 2015-2018(%)
Zero catch	0.00	0.00	0.00	0.00	316.41	479.76	51.63	-100.00
High long term yield (F0.1)	0.42	0.19	82.98	100.91	285.27	359.15	25.90	-26.97
Status quo	1.00	0.46	171.51	167.44	248.15	247.33	-0.33	50.95
Different scenarios	0.10	0.05	21.27	29.51	308.71	447.47	44.95	-81.28
	0.20	0.09	41.48	55.22	301.22	417.64	38.65	-63.49
	0.30	0.14	60.70	77.56	293.94	390.09	32.71	-46.57
	0.40	0.18	78.98	96.92	286.85	364.62	27.11	-30.49
	0.50	0.23	96.37	113.64	279.95	341.08	21.84	-15.19
	0.60	0.28	112.91	128.05	273.24	319.32	16.86	-0.63
	0.70	0.32	128.66	140.40	266.71	299.18	12.18	13.23
	0.80	0.37	143.64	150.94	260.35	280.55	7.76	26.42
	0.90	0.41	157.92	159.89	254.16	263.30	3.59	38.99
	1.10	0.50	184.47	173.75	242.29	232.54	-4.02	62.36
	1.20	0.55	196.82	178.98	236.59	218.83	-7.51	73.22
	1.30	0.60	208.59	183.27	231.04	206.12	-10.79	83.58
	1.40	0.64	219.81	186.72	225.64	194.33	-13.88	93.46

	1.50	0.69	230.52	189.45	220.39	183.39	-16.78	102.89
	1.60	0.73	240.74	191.55	215.27	173.24	-19.52	111.88
	1.70	0.78	250.49	193.09	210.29	163.82	-22.10	120.47
	1.80	0.83	259.81	194.16	205.44	155.06	-24.52	128.66
	1.90	0.87	268.70	194.82	200.72	146.92	-26.80	136.49
	2.00	0.92	277.21	195.11	196.13	139.35	-28.95	143.97

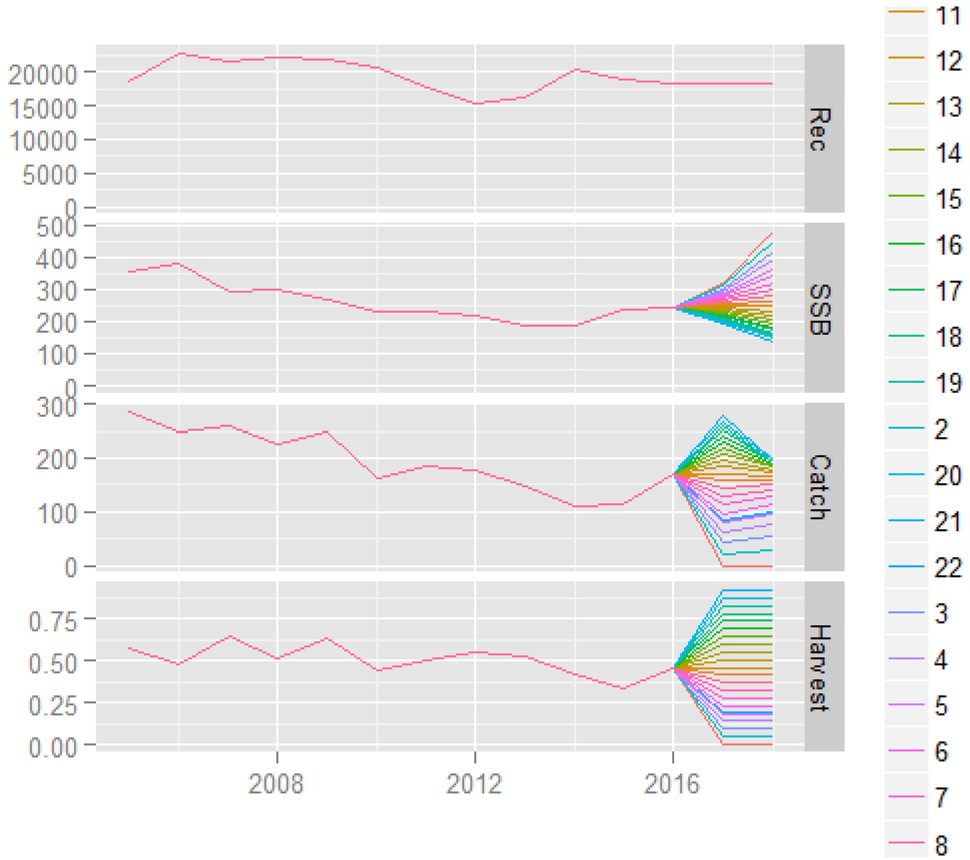


Figure 6.9.4.1. Norway lobster in GSA 9. Short term forecast in different F scenarios

6.9.5 QUALITY AND PROPOSALS FOR FUTURE ASSESSMENTS

Data from EU DCF as submitted through the Official data call in 2016 were used. For age distributions of landing and discard DCF available at the STCF EWG 14-09, it is not possible to know which growth parameters have been applied. For length frequency distributions, data are available for sex combined. For species like Norway lobster where growth rates are different by sex, it would be useful to have separate data by sex.

6.10 NORWAY LOBSTER IN GSA 11

6.10.1 DATA GATHERING OF NORWAY LOBSTER IN GSA 11

6.10.1.1 Stock Identity and Biology

Stock Identification

Nephrops norvegicus is a demersal, sedentary species (Chapman & Rice, 1971) widely distributed on the continental shelf and slope throughout the Iceland down to Morocco in the Atlantic sea and mainly in the west and central region of the Mediterranean (Figueiredo and Thomas, 1967; Farmer, 1975; Barquin *et al*., 1998; Tshudy, 2013). Its distribution is influenced by hydrological conditions and bottom types, more than depth.
The bathymetric distribution of Norway lobster is very wide, ranging between 4 and around 900 m (Abello *et al*., 1988; Holthuis, 1991; Johnson *et al*., 2013), but the highest concentrations can be found between 200 and 500 m. By the correlation analysis between environmental data and bathymetric distribution of *N. norvegicus*, showed the preference for cold waters with temperature comprised between 6.4 and 17.3 °C, and salinity between 31.8 and 38.8 ‰, with relatively high oxygen concentrations, between 4.16 and 6.61 ml/l (IOC-OBIS, 2015). In the Mediterranean the minimum depth of occurrence is along Adriatic coasts where catches are reported from 40-50 m depth (Froglia and Gramitto, 1981).
In the GSA 11 (Figure 6.10.1.1.1), the species occurred along all coasts with high concentration in north east and west areas. During the MEDITS survey carried out along 1994-2015 the species has been recorded at depths from about 117 m to a maximum of 680 m, but mainly around 475 m (Figure 6.10.1.1.2).

Due to a lack of information about the structure of *N. norvegicus* population in the western Mediterranean, this stock was assumed to be confined within the GSA 11 boundaries (Figure 6.10.1.1.1).

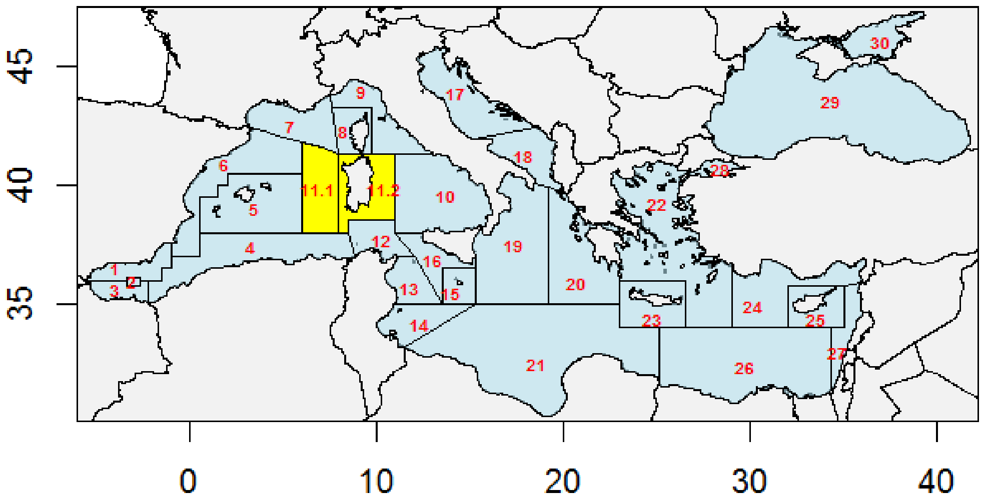


Figure 6.10.1.1.1. Geographical location of GSA 11.

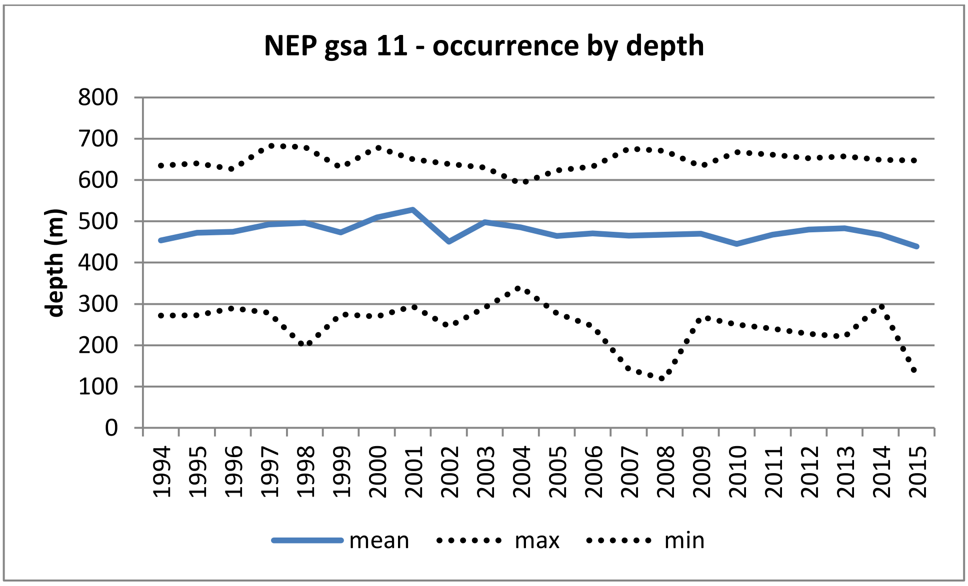


Figure 6.10.1.1.2. Norway lobster in GSA 11. Minimum, maximum and median depth of occurrence in GSA 11 (MEDITS survey).

According to the STOCKMED results a low differentiation and low support to the identification of genetic clusters within the Mediterranean was detected for Norway lobster thus supporting the conclusion on the absence of a clear geographical pattern of genetic differentiation among the populations studied.

However within smaller areas with different densities and life-history characteristics according to several authors (Maynou & Sardà, 1997; Bell et al., 2007) it is possible to have “sub-populations”, more related to the ecology of the species rather than genetic differences.

Age and growth

Nephrops norvegicus is a long-lived, slow growing species. Like all the crustaceans is characterized by discontinuous growth, with molts interspersed by intermolt periods and growth only occurring during the latter period. Several authors found that in adjacent waters growth of Norway lobster varies as a result of environmental conditions and density (Bailey and Chapman, 1983; Chapman and Bailey, 1987; Chapman and Howard, 1988; Tully and Hillis, 1995). An inverse proportional relation between density of burrows in a given area and the value of $L\infty$ suggests that growth should also be related to the number of individuals per unit area (Tuck *et al.*, 1997).

The growth pattern of *Nephrops norvegicus* is generally estimated by using indirect methods. The commonly used Von Bertalanffy growth function, however, has a number of shortcomings related to different life stages and sex (Bell et al., 2007).

The growth differs from juveniles and adults, and in adults from males to females. In the Mediterranean, juveniles of Norway lobster molt year-round while adult females only have one growing period per year, in December – March, soon after hatching. Males grow larger than females (Vrgoč et al., 2004; Bell et al. 2007) although growth rates (k) are almost similar. However females, particularly when have fertilized eggs, spend most of time in lying in the burrows then an underestimation of female’s growth should be related with their less vulnerability to bottom trawls and a consequent less representation in the size distributions (Bell et al., 2006) that affect growth estimation.

There are not specific studies on growth of Norway lobster for GSA 11 but growth parameters information reported for some neighboring GSAs (GSA9, GSA10) in Relini et al. (1999) shows that males have a greater $L\infty$ than females, but similar growth rates (k).

As informed by DCF, for GSA 11 growth parameters of *N. norvegicus* were only available for males, and they were similar to the equivalent values reported in GSA 9 by EWG 14-17. Therefore, growth parameters from GSA 9 were used in GSA 11 (Table 6.10.1.1.1).

Table 6.10.1.1.1. Norway lobster in GSA 11. Growth parameters (Linf, K, t0) and parameters of the Length-Weight relationship (a, b) used for the assessment (taken from GSA 9)

Sex	Linf (mm)	K	t0	a	b	source
M	72	0.17	0	0.0005	3.104	DCF, GSA11
M	72	0.17	0	0.0003	3.193	EWG 14-17, GSA 9
F	56	0.21	0	0.0004	3.189	EWG 14-17, GSA 9
C	74.1	0.17	0	0.0001	3.08	EWG 14-17, GSA 9

Maturity

The maturity cycle of Norway lobster shows a clear seasonal pattern related on water temperature but it can be locally due to depth and geographic factors. According to Orsi Relini *et al*. (1998) latitude and circadian rhythms can influence the reproductive process even in individuals living at greater depths; generally at a lower depth and latitude, reproductive events occurs slightly in advance. Ovary development is typically described according to a multi-stage scale, allowing the determination of maturation by means of a macroscopic analysis of ovary colour and size (Farmer, 1974; ICES, 2010).

In Mediterranean Norway lobster spawns once a year (Froglia and Gramitto, 1981, Orsi Relini *et al*., 1998) and gonadal maturation usually starts in January-March and the maturity process is completed from late-spring/summer through early autumn (Orsi Relini *et al*., 1998, Mente *et al*., 2009).

After spawning, which typically occurs in late summer and early autumn (Bell *et al*., 2006), we have the berried female stage in pleiopods. Eggs incubation range between 4 and 6 months according to latitude or temperature (Bianchini *et al*., 1998, Mori *et al*., 1998; Sarda, 1995; Powell and Eriksson, 2013).

A certain variability in size at first sexual maturity of females was reported both for the Atlantic and Mediterranean populations. In the Mediterranean, the smallest mature individuals were reported in the Catalan Sea and in the Adriatic Sea, those of intermediate size in the Ligurian Sea, Tyrrhenian Sea and Gulf of Eubea (Aegean Sea), the largest ones in the Alboran Sea (Abello and Sarda, 1982; Orsi Relini *et al*., 1998).

Age at first maturity is thought to be around 2-3 years (Froglia and Gramitto 1981, Orsi Relini et al. 1998).

For *N. norvegicus*, there is a difference in maturity at age between males and females, with the former maturing earlier than the latter. The DCF information on maturity at age of *N. norvegicus* in GSA 11 was reported for females and males for 2014 and for females only for 2015 (Table 6.10.1.1.2).

Table 6.10.1.1.2. Norway lobster in GSA 11. Maturity at age vectors from DCF

Sex	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	Source
F	0	0.25	0.856	1	1	1	1	1	DCF (2015)
F	0	0.727	0.826	1	1	1	1	1	DCF (2014)
M	1	1	1	1	1	1	1	1	DCF (2014)

Feeding

N. norvegicus is a scavenger and predator (Baden *et al*., 1990; Cristo and Cartes, 1998; Loo *et al*., 1993). It has a diversified diet, which includes crustaceans, echinoderms, polycheaetes, molluscs, foraminiferans and fishes (Baden *et al*., 1990; Cristo and Cartes, 1998). Being a general predator, its food preferences vary by region and involve the most available species in the occupied area

(Figueiredo, 1989). In general, *N. norvegicus* has only a few predators (Serrano *et al*., 2003). In the Atlantic Ocean, *Gadus morhua* is the main predator of *N. norvegicus* (Chapman, 1980; Pinnegar and Platts, 2011), which anyway seems to prefer other preys, more profitable from the energy point of view. Remains of *N. norvegicus* were found in the stomachs of *Scyliorhinus canicula* and *Raya clavata* (Thomas, 1965). Also invertebrates, as well as some benthic cephalopods, may be considered as *N. norvegicus* predators (Coll *et al*., 2006). Although difficult to estimate, cannibalism was reported both in nature and in captivity (Baden *et al*., 1990; Cristo and Cartes, 1998; Sarda and Valladares, 1990).

Habitat

Although is able to swim (Relini *et al*., 1999), *N. norvegius* is preferably distributed on slope edge bottoms where digs burrows characterized by a concave entrance, followed by a tubular gallery. The gallery is located longitudinally at about 20-30 cm depth in seabed sediment and includes a variable number of "ventilation shafts" (Rice and Chapman, 1971; Atkinson and Chapman, 1984). For the construction of burrows where they use to live, they prefer muddy-sandy bottoms (Artegiani *et al.*, 1979; Chapman, 1980; Fernandez and Farina, 1984), with a medium-grained composition (~ 40% of clay and silt) (Farmer, 1975; Afonso-Dias, 1998; Bell et al., 2007). *N. norvegicus* spends most of its time lying in such burrows; due to its behaviour when it emerges, makes it vulnerable to bottom trawling, and is associated to light and other environmental and demographic factors, (food availability, appetite, size, stage of breeding, territorial behaviour and mating) (Chapman *et al*., 1975; Bell *et al*., 2006; Aguzzi and Sarda, 2008). While the adults show a sedentary ethology living almost segregated in the nearest area of burrows, the larvae, characterized by a 2-7 weeks pelagic phase (Bell et al., 2007), have a great mobility.

Individual spatial distribution seems to be related essentially to the nature of seabed sediments. It was noted that *N. norvegicus* density increases when silt and clay proportion, with respect to sand in seabed sediments, increases, till it reaches an *optimum* value (quantified in moderately high proportions of silt and clay), and decreases again with thinner granulation sizes (Campbell *et al*., 2009).

This heterogeneity in distribution is also present within smaller areas, giving rise to smaller "sub-populations" with different densities and life-history characteristics (Maynou & Sardà, 1997; Bell et al., 2007).

Natural mortality

The natural mortality vector was calculated using Prodbiom (Abella et al. 1997) and it was the same for both sexes (Table 6.10.1.1.3).

Table 6.10.1.1.3. Norway lobster in GSA 11. Natural mortality vector.

Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7+
0.48	0.36	0.3	0.27	0.26	0.24	0.23

6.10.1.2 Catch data

Landings of *N. norvegicus* in GSA 11 are exclusively provided by trawling (Table 6.10.1.2.1). Landings varied from 6.29 (2005) to 50.49 (2011) tons (Figure 6.10.1.2.1), exhibiting large variations during recorded years. Since 2011 the annual landings have decreased.

Table 6.10.1.2.1. Norway lobster in GSA 11 Landings (t) by trawling fleet (OTB) in GSA11

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
landings	6.29	42.27	31.33	36.17	44.41	22.77	50.49	41.12	20.62	17.23	18.25

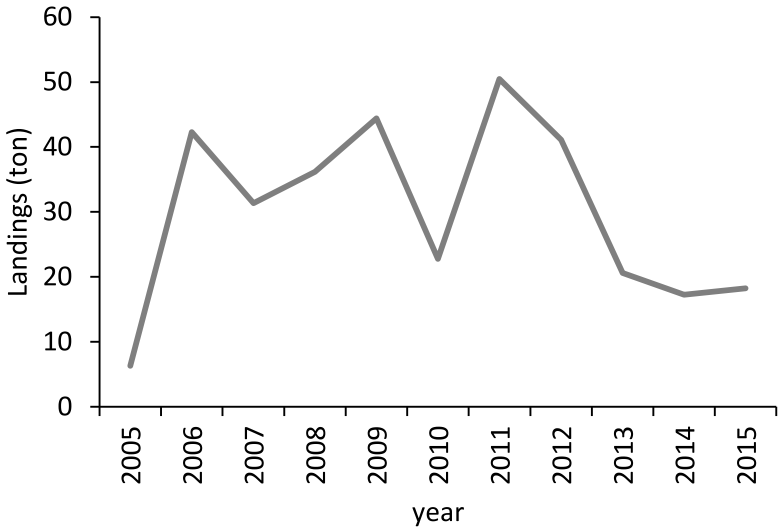


Figure 6.10.1.2.1. Norway lobster in GSA 11. Trend on Landings (t) (DCF official data).

Length structure of the specimens caught by trawling fleet was quite variable along the recorded years, becoming more stable since 2013 (table. 6.10.1.2.2 and Figure 6.10.1.2.2). Landings are mostly composed by specimens from 25 to 50 mm CL and generally show a polymodal composition (Figure 6.10.1.2.2)

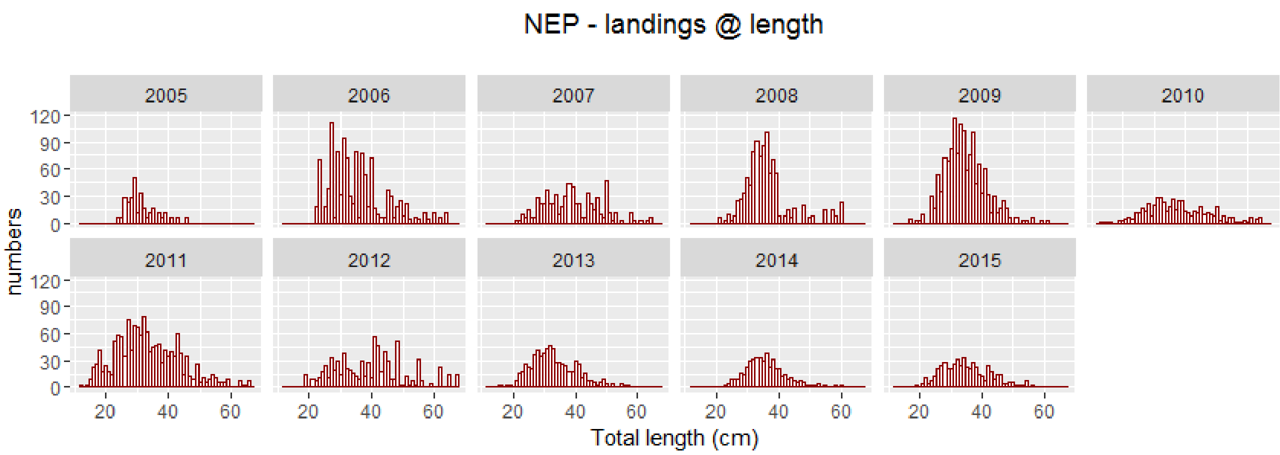


Figure 6.10.1.2.2. Norway lobster in GSA 11. Length structure of specimens landed by the trawling fleet in GSA11

Discards

According to the 2016 official DCF data call, the fishery of N. norvegicus in GSA11 did not produce discards from 2005 to 2015.

6.10.1.3 Fishing effort data

Number of vessels with OTB has exhibited fluctuations with no particular trend in 2004-2015 (Figure 6.10.1.3.1 a). OTB days at sea increased in 2004-2010 and then decreased in 2010-2015. Nominal effort (kW*Days at sea) of OTB has exhibited an overall decreasing trend in 2004-2015 (Figure 6.10.1.3.1 c).

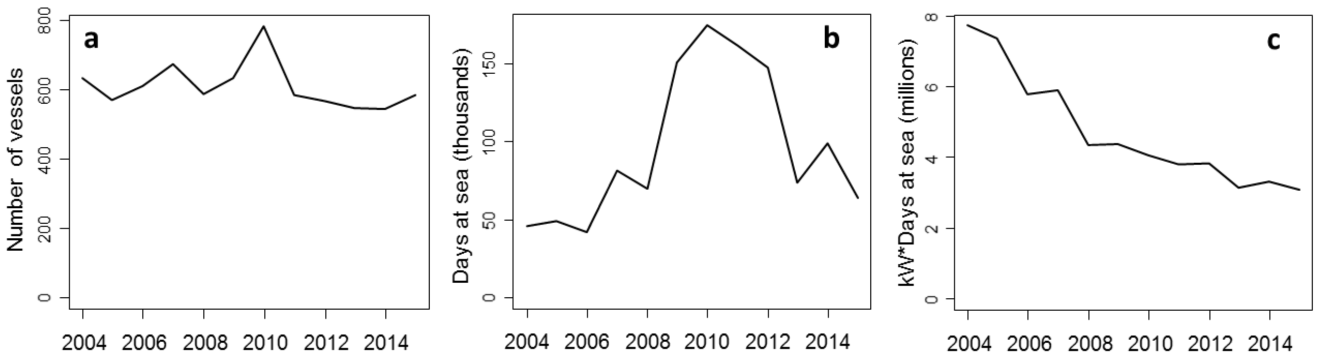


Figure 6.10.1.3.1. Temporal development of OTB fishing effort in GSA 11 in 2004-2015 in terms of number of vessels (a), days at sea (b), and kW*Days at sea (c).

Table 6.10.1.3.1. OTB effort in GSA 11

Year	Number of vessels	Days at sea	kW*Days at sea
2004	630	45626.91	7706431
2005	568	49328.09	7324728
2006	607	41867.89	5752588
2007	671	81583.76	5867826
2008	586	70116.55	4326313
2009	631	150782.8	4370758
2010	782	174751.9	4036734
2011	581	161502	3788057
2012	565	147746.3	3824269
2013	543	74028	3139044
2014	542	99029.23	3298194
2015	581	64296.26	3087757

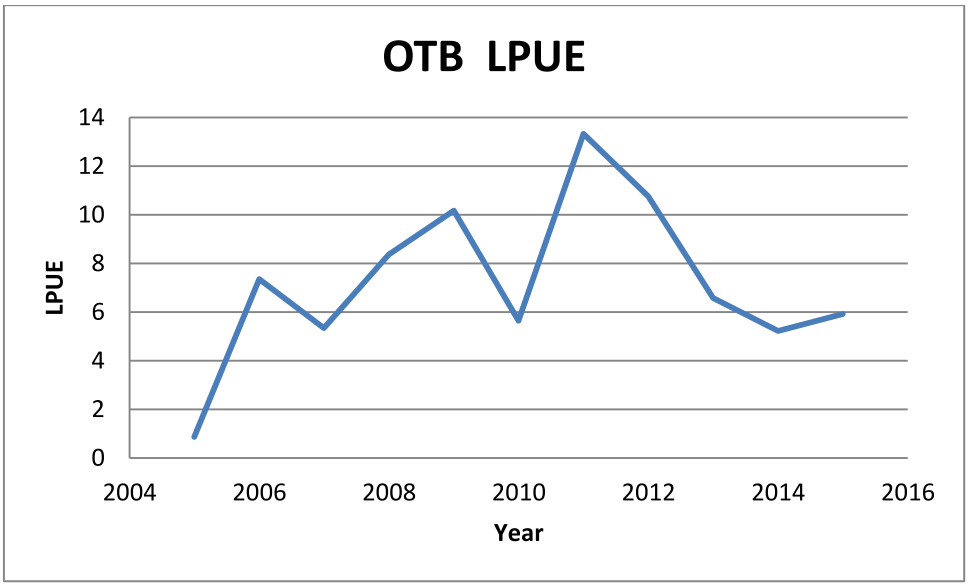


Figure 6.10.1.3.2. Temporal development of OTB LPUE (grams/kWday) or N. norvegicus in GSA 11 during 2005-2015

6.10.1.4 Survey Indices of abundance and biomass by year and size/age

The MEDITS survey was used to infer abundance and biomass indices for *N. norvegicus*. In the GSA 11 MEDITS start in 1994, covering all coast around the island. Number of hauls per year changed in 2002 from around 120 to about 100 hauls per year (Table 6.10.1.4.1).

Table 6.10.1.4.1. Number of total MEDITS hauls carried out in GSA 11 in 1994-2015.

1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
116	107	125	126	123	123	123	122	99	99	95	97	98	100	95	97	99	101	101	101	102	99

The mean occurrence of *N. norvegicus* in the area along the time series was about the 0.28 (range 0.25-0.33) (Table 6.10.1.4.2).

Table 6.10.1.4.2. Norway lobster in GSA 11. Occurrence of Nephrops norvegicus in the MEDITS hauls.

1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
0.27	0.25	0.33	0.33	0.33	0.24	0.27	0.26	0.25	0.27	0.26	0.26	0.29	0.30	0.28	0.28	0.32	0.26	0.28	0.29	0.25	0.26

The MEDITS indices indicated fluctuations with no particular trend in 1994-2010 followed by low values in the last years (Figure. 6.10.1.4.1).

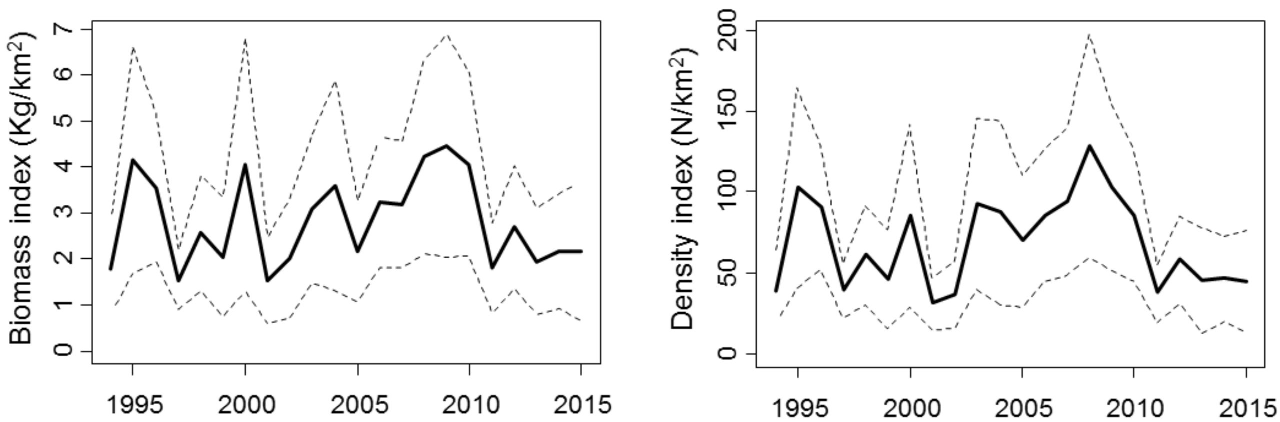
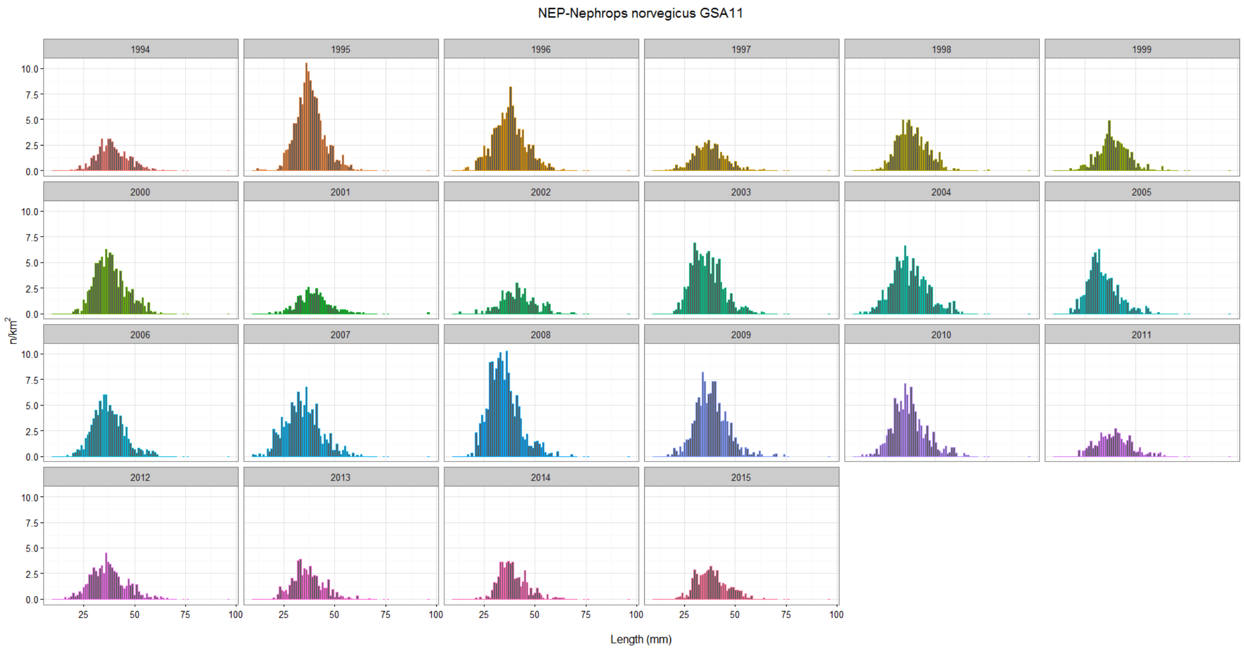
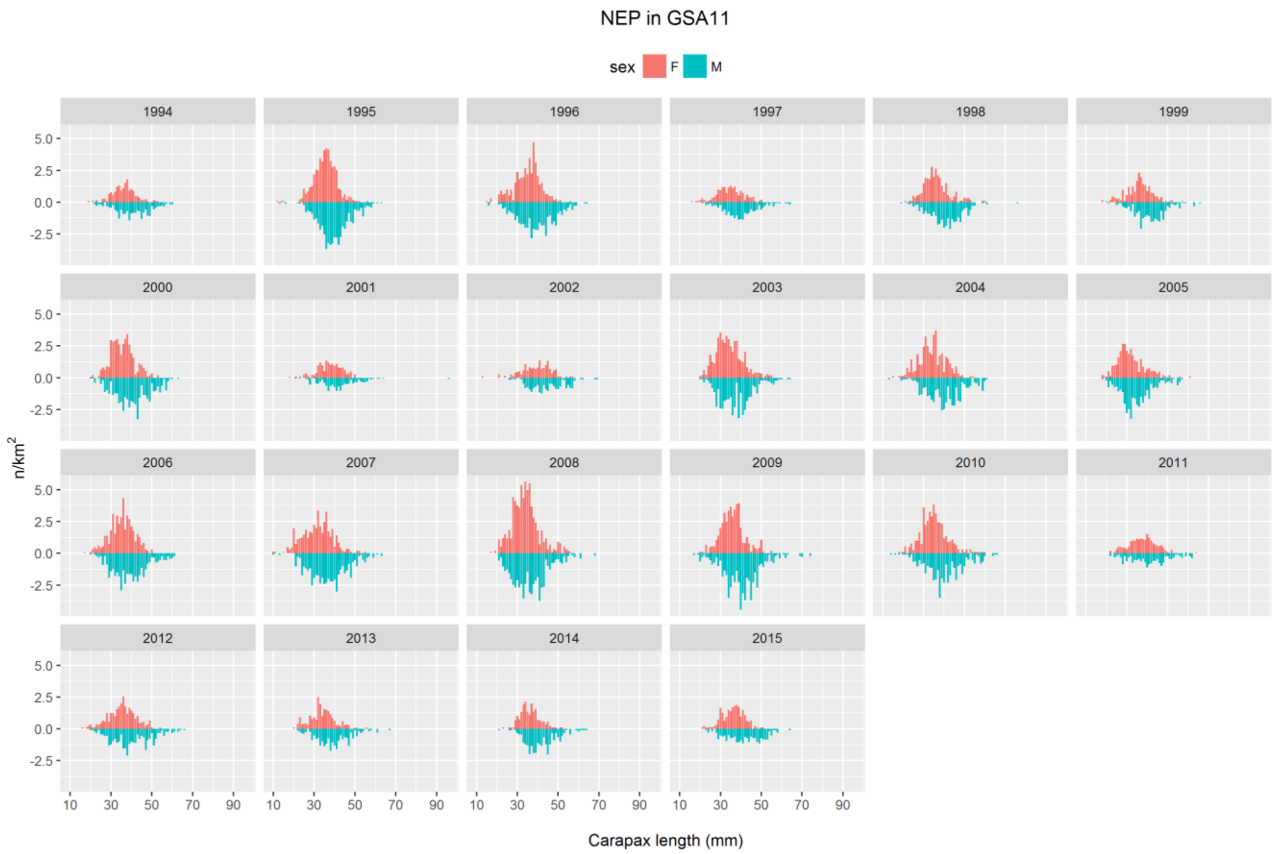


Figure 6.10.1.4.1. Norway lobster in GSA 11. Biomass and density index based on MEDITS data. Dashed lines indicate 95% confidence intervals.

The standardized length structures of the MEDITS catches show generally a unimodal distribution but differ by sex on ranges (Figure 6.10.1.4.2). In terms of size distribution, MEDITS LFDs were similar to these from landings.



A



B

Figure 6.10.1.4.2. Norway lobster in GSA 11. Stratified abundance indices by size from MEDITS survey 1994-2015 (length bins = 1 mm Carapace Length) - sex combined (A), males and females (B).

6.10.2 STOCK ASSESSMENT ON NORWAY LOBSTER IN GSA 11

In GSA 11 the Norway Lobster was never assessed before in an STECF meeting. The data provided to EWG 16-17 has been considered covering more than the mean life span of the species, allowing to makes an attempt of stock assessment with an XSA method.

The XSA analysis was carried out using two approaches: the former take in to account the difference on growth parameters by sex (section 6.10.2.1), the latter uses sex combined (6.10.2.2).

Method 1- (XSA – sex separated)

Using the FLR libraries (Kell et al. 2007) an Extended Survivors Analysis (XSA – Darby and Flatman, 1994) was carried out to assess trends in fishing mortality, stock biomass, spawning stock biomass, and recruitment of *Nephrops norvegicus* in the GSA 11. The time series considered was of 11 years (2005-2015).

Input data

The XSA was applied using as input data the DCF official data. Since the growth pattern of *N. norvegicus* is generally estimated by using indirect methods, the catch at age information are generally derived by a slicing procedure. However, the limited DCF information on growth for the GSA 11 push EWG 16-17 to use for the assessment the growth parameters of GSA 9 as reported above (Table 6.10.1.1.1). That requires catch numbers at age to be derived directly by splitting the catch at length information of GSA 11 rather than use the DCF catch at age data.
To derive catch numbers at age from the DCF annual size distributions a knife edge slicing technique was applied taking in to account the difference on growth parameter by sex. For this aim the catch at length information, reported for sex combined, and were converted in catch at length by sex using the sex ratio DCF information reported for the GSA 9. Finally, catch numbers at age of females and males were aggregated to obtain one total catch at age matrix to be used as input file for the XSA (Table 6.10.2.2). The same procedure was applied to the MEDITS data; numbers at length by sex were first split to numbers at age by sex and then aggregated (Table 6.10.2.2). For big individuals a 7+ group was used.
Due to differences on SOP a correction was applied to the catch at age matrix using a SOP correction factor (SOP = Landings / Σx_a (x_a= product of catch numbers at age and weight-at-age)) as reported in the Table 6.10.2.1. The factors are fairly consistent over years and are not expected to influence the assessment in terms of F and a simple scaling factor on SSB.

Table 6.10.2.1. Norway lobster in GSA 11. SOP correction factor applied to the catch at age matrix.

year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
SOP factor	0.858	0.846	0.865	0.871	0.870	0.893	0.874	0.881	0.875	0.886	0.875

The proportion at age shows that catches are concentrated on ages 2-4 (Figure 6.10.2.1.1.1).

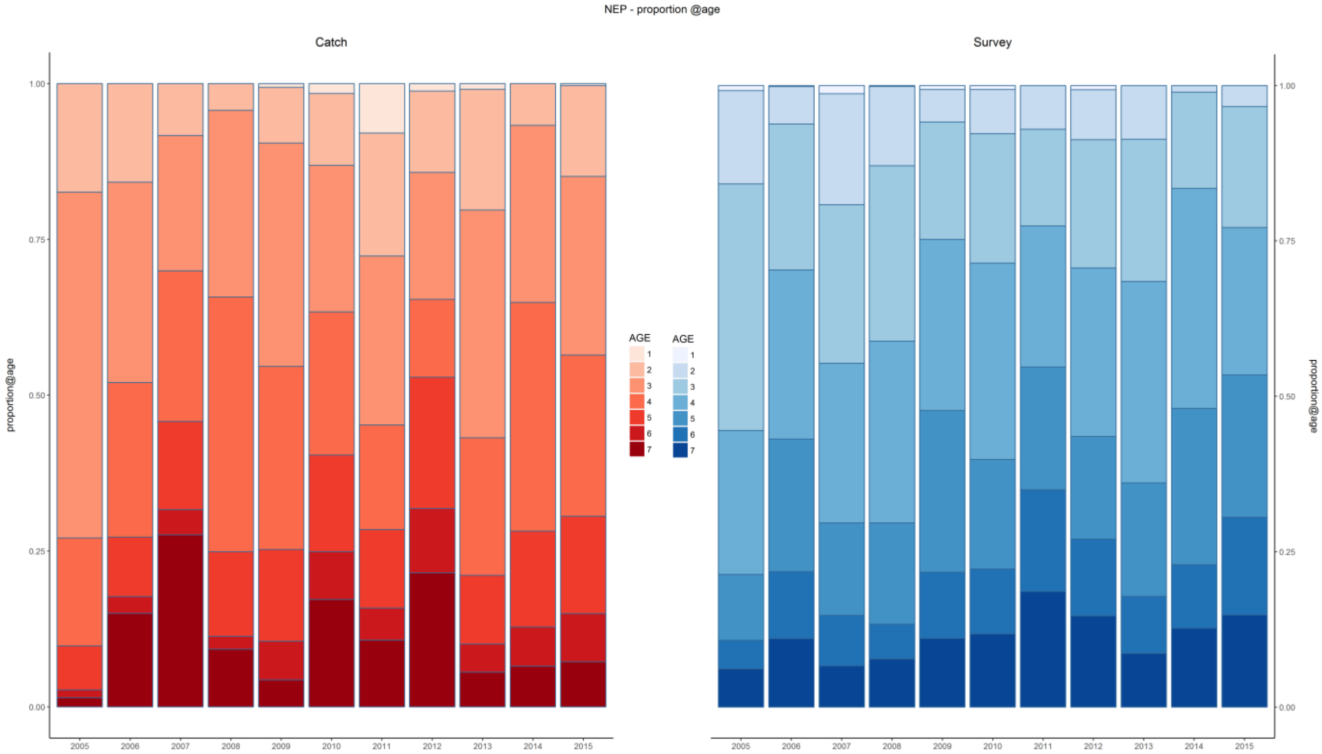


Figure 6.10.2.1. Norway lobster in GSA 11. Proportion at age of catch and tuning data by year.

The trends of numbers at ages are reported for catches (Figure 6.10.2.2 a) and MEDITS data (Figure 6.10.2.2 b).

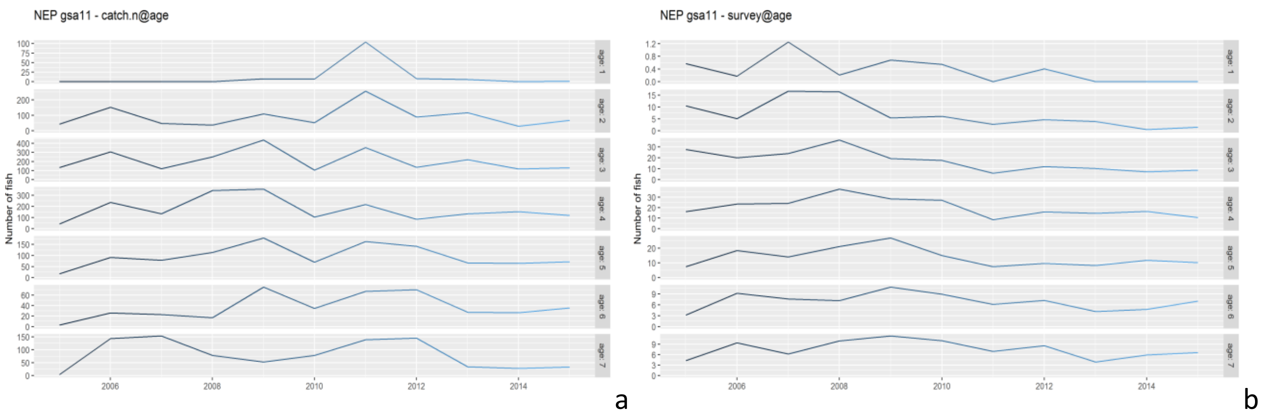


Figure 6.10.2.2. Norway lobster in GSA 11. Trend of catch at age for landings (a) and survey data (b).

To be consistent with the growth parameter used to split the length data, also the maturity vector used for the assessment was adopted from that reported for GSA9.

A natural mortality vector computed using ProdBiom (Abella, 1998) was used. All the input parameters (landings, catch number at age, weight at age, maturity at age, natural mortality at age and the tuning series at age) used in the XSA were listed below (Table 6.10.2.2).

Table 6.10.2.2. Norway lobster in GSA 11. Input parameters and data for XSA assessment

TUNING
MEDITS

age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	0.6	0.2	1.2	0.2	0.7	0.6	0	0.4	0	0	0
2	10.5	5.1	16.8	16.4	5.4	6.1	2.7	4.7	3.9	0.5	1.5
3	27.7	20.1	23.9	36.3	19.5	17.7	5.8	12.1	10.4	7.2	8.7
4	16.1	23.3	24.1	37.6	28.4	27	8.5	15.9	14.7	16.5	10.6
5	7.4	18.3	14	21	26.8	15	7.4	9.7	8.3	11.7	10.2
6	3.2	9.2	7.6	7.2	10.9	8.9	6.2	7.2	4.2	4.8	7
7	4.3	9.4	6.2	10	11.4	10	7	8.6	3.9	5.9	6.6

initial settings

min	max	plusgroup	Minyear	maxyear	minfbar	maxfbar
1	7	7	2005	2015	2	6

Mortality and Maturity vectors@age

	1	2	3	4	5	6	7
maturity	0.1	0.25	0.5	0.8	1	1	1
mortality	0.48	0.36	0.3	0.27	0.26	0.24	0.23

Mean Weight@age (kg) in stock, catch, landings

age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.005
2	0.013	0.011	0.012	0.012	0.012	0.011	0.011	0.011	0.011	0.012	0.012
3	0.020	0.021	0.022	0.023	0.022	0.022	0.021	0.021	0.022	0.023	0.022
4	0.036	0.037	0.038	0.035	0.036	0.037	0.037	0.038	0.037	0.036	0.037
5	0.052	0.057	0.056	0.058	0.052	0.056	0.054	0.054	0.053	0.054	0.055
6	0.068	0.074	0.073	0.077	0.073	0.074	0.074	0.075	0.077	0.073	0.073
7	0.127	0.127	0.110	0.129	0.110	0.122	0.129	0.145	0.116	0.116	0.108

catch in weight (ton) by year

age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
all	6.29	42.3	31.3	36.2	44.4	22.8	50.5	41.1	20.6	17.2	18.25

Catch at age matrix (numbers in thousands)

age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	0	0	0	0	7	7	104	8	6	0	2
2	42	152	47	36	109	52	257	88	117	28	67
3	134	307	121	251	436	106	352	138	221	119	132
4	42	238	135	343	357	104	218	85	133	154	119
5	17	91	79	114	179	70	164	142	67	65	72
6	3	26	23	17	75	35	67	70	27	26	36
7	4	144	154	78	53	78	139	145	34	27	33

Results

A sensitivity analysis was performed to select the most suitable parameters to be used in the XSA in terms of minimizations of residuals. Using all the parameters combination of rage (0 to 1, step of 1), qage (1 to 5, step of 1), shk.ages (1 to 3, step of 1) and fse (0.5 to 3, step of 0.5) a total of 180 different XSA runs were carried out and outputs in term of residual were evaluated. Residuals range from -12.85 to 13.01 (1st quartile -0.12, interquartile range 1.14). Means calculated on the absolute value of residuals (mean_absres) for each run range from 0.22 to 7.74 (mean 1.7, 1st quartile 0.30, interquartile range 1.02).

To choose the best setting among all 180 runs we preselect only those runs showing the lower mean_absres, and a diagnostic analysis of retrospective performances was carried out on them. As a criteria of selection for progress in the sensitive analysis the run with mean_absres lower than the first quartile(0.30) were chosen (n=45, Table 6.10.2.3, Figure 6.10.2.3).

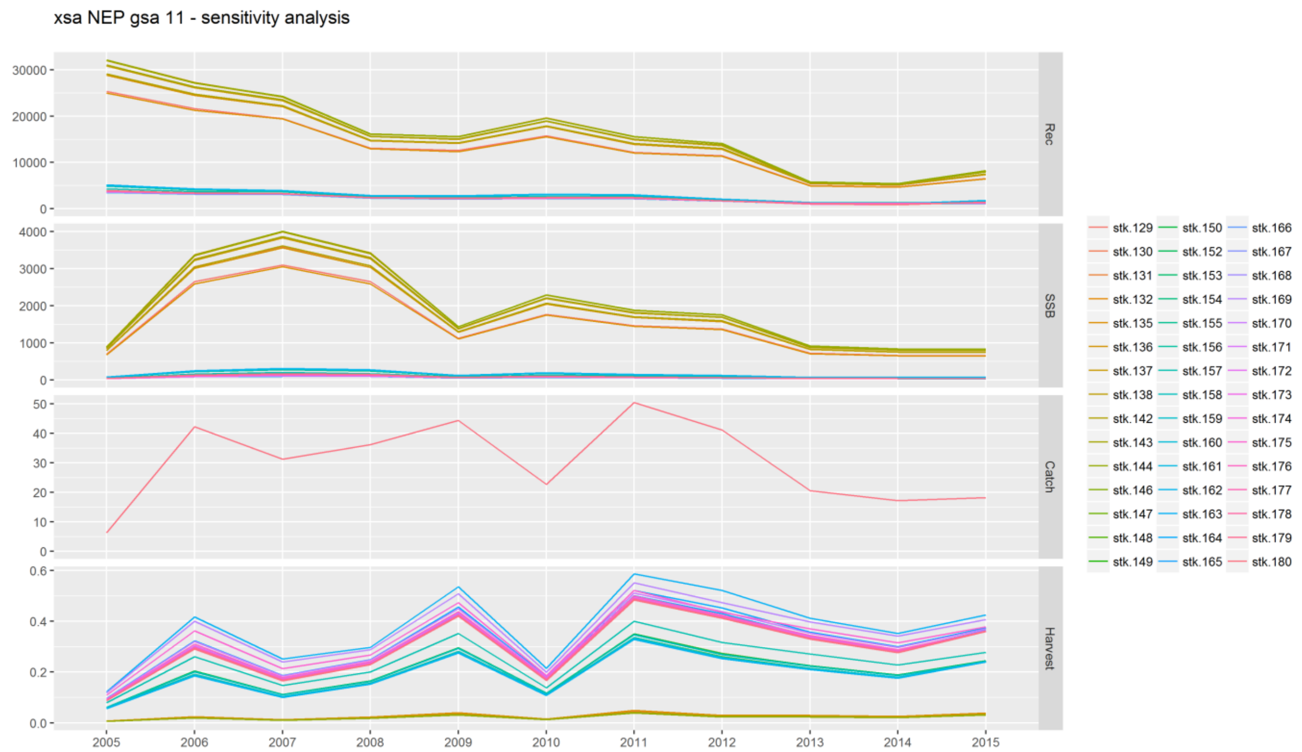


Figure 6.10.2.3. Norway lobster in GSA 11. Sensitivity analyses of all the preselected XSA runs (n=45).

Table 6.10.2.3. Norway lobster in GSA 11. Settings for the sensitivity analysis and min, max and mean values of absolute residuals for all the preselected runs (n=45).

run_n	setsens	shkage	fse	rage	qage	minres	maxres	absmean	absmax
174	sh2se3r1q5	sh2	se3	r1	q5	-1.436	0.889	0.219	1.436
168	sh1se3r1q5	sh1	se3	r1	q5	-1.436	0.890	0.219	1.436
180	sh3se3r1q5	sh3	se3	r1	q5	-1.436	0.889	0.219	1.436
173	sh2se2.5r1q5	sh2	se2.5	r1	q5	-1.442	0.890	0.219	1.442
167	sh1se2.5r1q5	sh1	se2.5	r1	q5	-1.442	0.892	0.219	1.442
179	sh3se2.5r1q5	sh3	se2.5	r1	q5	-1.441	0.890	0.219	1.441
172	sh2se2r1q5	sh2	se2	r1	q5	-1.451	0.893	0.219	1.451
166	sh1se2r1q5	sh1	se2	r1	q5	-1.451	0.895	0.219	1.451
178	sh3se2r1q5	sh3	se2	r1	q5	-1.450	0.892	0.219	1.450
171	sh2se1.5r1q5	sh2	se1.5	r1	q5	-1.467	0.897	0.220	1.467
165	sh1se1.5r1q5	sh1	se1.5	r1	q5	-1.467	0.900	0.220	1.467

run_n	setsens	shkage	fse	rage	qage	minres	maxres	absmean	absmax
177	sh3se1.5r1q5	sh3	se1.5	r1	q5	-1.466	0.896	0.220	1.466
170	sh2se1r1q5	sh2	se1	r1	q5	-1.501	0.902	0.221	1.501
164	sh1se1r1q5	sh1	se1	r1	q5	-1.502	0.911	0.221	1.502
176	sh3se1r1q5	sh3	se1	r1	q5	-1.499	0.902	0.221	1.499
175	sh3se0.5r1q5	sh3	se0.5	r1	q5	-1.577	0.922	0.231	1.577
156	sh2se3r1q4	sh2	se3	r1	q4	-1.402	0.924	0.232	1.402
150	sh1se3r1q4	sh1	se3	r1	q4	-1.402	0.925	0.232	1.402
162	sh3se3r1q4	sh3	se3	r1	q4	-1.402	0.923	0.232	1.402
155	sh2se2.5r1q4	sh2	se2.5	r1	q4	-1.408	0.925	0.232	1.408
149	sh1se2.5r1q4	sh1	se2.5	r1	q4	-1.408	0.927	0.232	1.408
161	sh3se2.5r1q4	sh3	se2.5	r1	q4	-1.408	0.925	0.232	1.408
154	sh2se2r1q4	sh2	se2	r1	q4	-1.418	0.928	0.233	1.418
148	sh1se2r1q4	sh1	se2	r1	q4	-1.418	0.931	0.233	1.418
160	sh3se2r1q4	sh3	se2	r1	q4	-1.418	0.927	0.233	1.418
153	sh2se1.5r1q4	sh2	se1.5	r1	q4	-1.437	0.933	0.233	1.437
147	sh1se1.5r1q4	sh1	se1.5	r1	q4	-1.436	0.938	0.234	1.436
159	sh3se1.5r1q4	sh3	se1.5	r1	q4	-1.436	0.932	0.234	1.436
152	sh2se1r1q4	sh2	se1	r1	q4	-1.476	0.938	0.236	1.476
146	sh1se1r1q4	sh1	se1	r1	q4	-1.475	0.951	0.236	1.475
158	sh3se1r1q4	sh3	se1	r1	q4	-1.475	0.935	0.236	1.475
169	sh2se0.5r1q5	sh2	se0.5	r1	q5	-1.579	0.911	0.238	1.579
163	sh1se0.5r1q5	sh1	se0.5	r1	q5	-1.582	0.918	0.241	1.582
157	sh3se0.5r1q4	sh3	se0.5	r1	q4	-1.568	0.930	0.257	1.568
132	sh1se3r1q3	sh1	se3	r1	q3	-1.156	0.907	0.295	1.156
138	sh2se3r1q3	sh2	se3	r1	q3	-1.158	0.905	0.295	1.158
144	sh3se3r1q3	sh3	se3	r1	q3	-1.158	0.904	0.295	1.158
131	sh1se2.5r1q3	sh1	se2.5	r1	q3	-1.167	0.908	0.295	1.167
137	sh2se2.5r1q3	sh2	se2.5	r1	q3	-1.169	0.905	0.296	1.169
143	sh3se2.5r1q3	sh3	se2.5	r1	q3	-1.169	0.904	0.296	1.169
130	sh1se2r1q3	sh1	se2	r1	q3	-1.185	0.910	0.296	1.185
136	sh2se2r1q3	sh2	se2	r1	q3	-1.188	0.906	0.296	1.188
142	sh3se2r1q3	sh3	se2	r1	q3	-1.188	0.905	0.296	1.188
129	sh1se1.5r1q3	sh1	se1.5	r1	q3	-1.218	0.914	0.298	1.218
135	sh2se1.5r1q3	sh2	se1.5	r1	q3	-1.224	0.908	0.299	1.224

The best retrospective performance was shown by the run number 174 (Figure 6.10.2.4). The recruitment estimation shows a decreasing trend but looks instable. A better pattern was observed in the retrospective analysis of fishing mortality which was more stable, showing a decreasing trend until 2014 and a weak increase of F in the last year (2015).

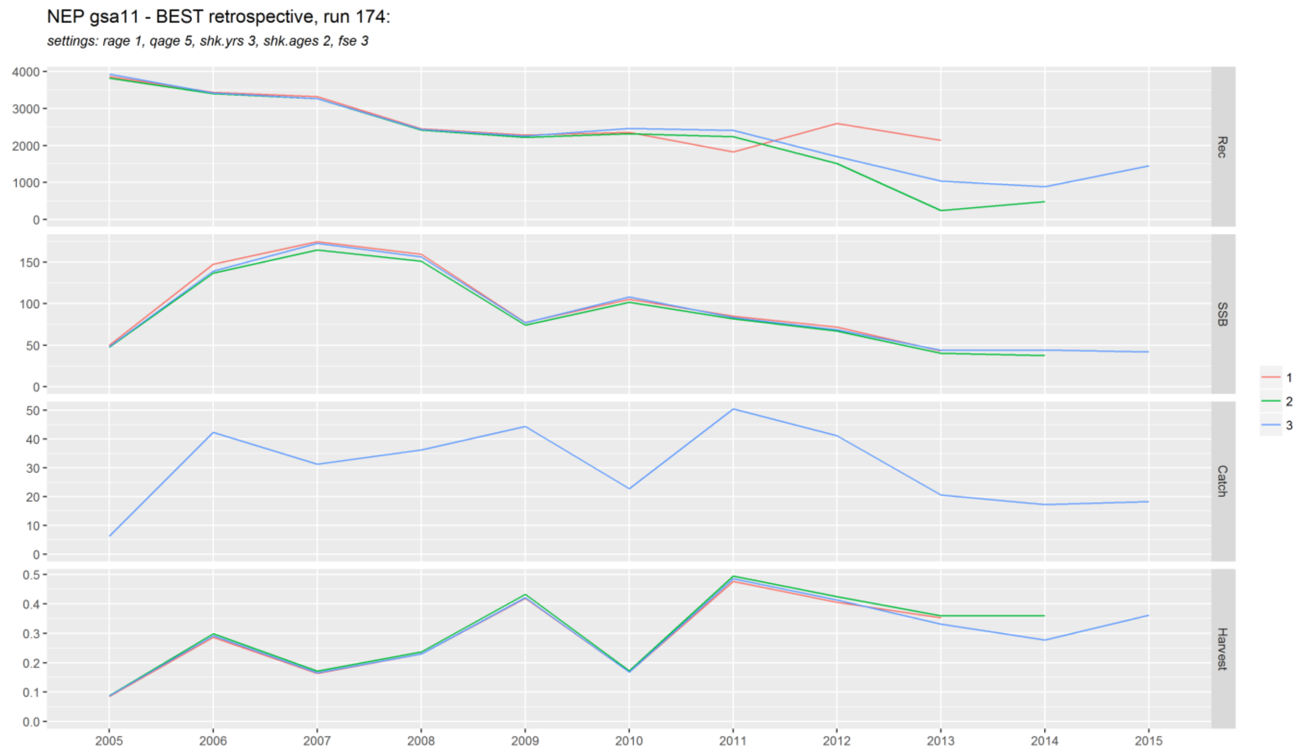


Figure 6.10.2.4. Norway lobster in GSA 11. Retrospective analyses of the best XSA run.

The log-catchability residuals of the assessment are listed (Table 6.10.2.4) and plotted (Figure 6.10.2.5). The residuals do not show any trend and are very small.

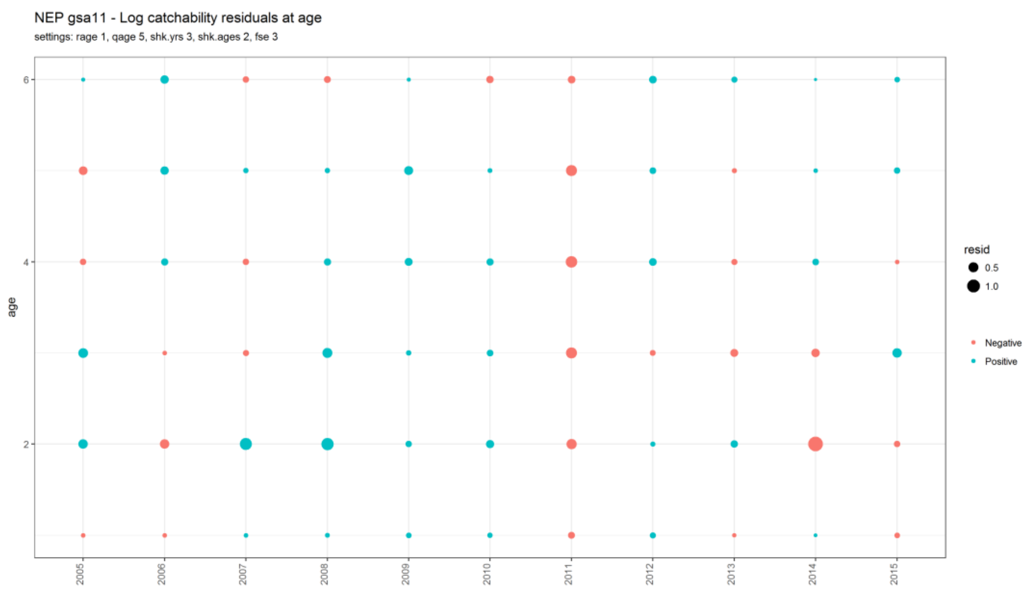


Figure 6.10.2.5. Norway lobster in GSA 11. Log-catchability residuals of XSA.

Table 6.10.2.4. Norway lobster in GSA 11. Log-catchability residuals of XSA.

Log catchability residuals of XSA

age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	-0.02	-0.026	0.026	0.029	0.068	0.05	-0.145	0.099	-0.018	0.007	-0.069
2	0.422	-0.425	0.866	0.889	0.108	0.282	-0.522	0.038	0.192	-1.436	-0.106

3	0.465	-0.026	-0.092	0.496	0.057	0.128	-0.674	-0.084	-0.232	-0.284	0.43
4	-0.119	0.161	-0.104	0.177	0.237	0.174	-0.742	0.222	-0.096	0.132	-0.026
5	-0.341	0.286	0.057	0.053	0.344	0.03	-0.642	0.122	-0.045	0.021	0.104
6	0.012	0.295	-0.108	-0.156	0.013	-0.202	-0.212	0.214	0.1	0.004	0.065

The XSA results show a decreasing trend in recruitment and an increasing trend in fishing mortality (F2-6). The estimated F_{curr} was 0.36 (Figure 6.10.2.6, Table 6.10.2.5).

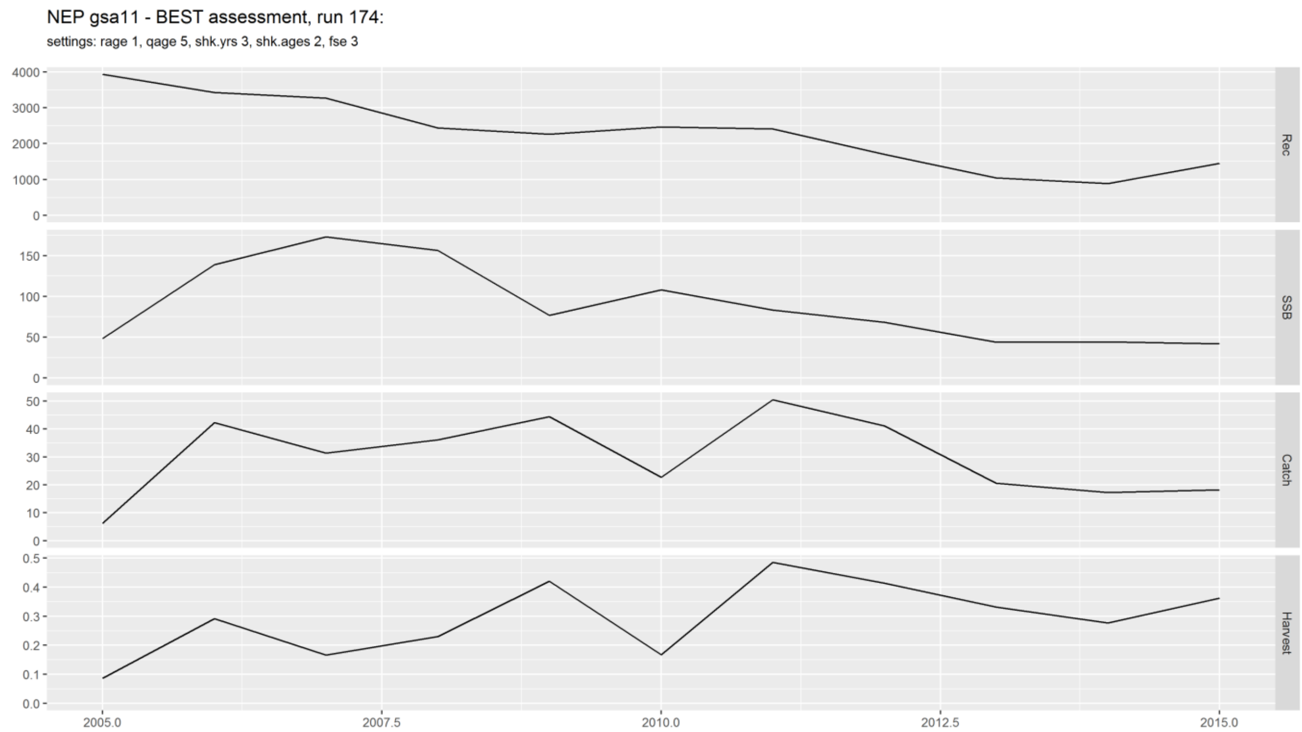


Figure 6.10.2.6. Norway lobster in GSA 11. XSA summary results. SSB and catch are in tons, recruitment in 1000s individuals.

Table 6.10.2.5. Norway lobster in GSA 11. XSA summary, fishing mortality and stock numbers at age (thousands).

XSA summary

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
ssb	48.5	139.1	172.8	156.3	77	108.2	83.3	68.5	44	44.3	41.9
fbar	0.09	0.29	0.17	0.23	0.42	0.17	0.49	0.41	0.33	0.28	0.36
rec	3930	3419	3266	2435	2261	2465	2406	1700	1041	882	1447
catch	6.3	42.3	31.3	36.2	44.4	22.8	50.5	41.1	20.6	17.2	18.2

Fishing mortality by year estimated with XSA

age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	0	0	0	0	0	0	0.06	0.01	0.01	0	0
2	0.02	0.08	0.03	0.02	0.09	0.05	0.23	0.08	0.14	0.05	0.16
3	0.16	0.29	0.09	0.23	0.46	0.14	0.58	0.21	0.33	0.25	0.45
4	0.1	0.51	0.22	0.46	0.66	0.2	0.52	0.29	0.36	0.45	0.47
5	0.09	0.37	0.33	0.32	0.51	0.27	0.62	0.85	0.42	0.32	0.43
6	0.06	0.21	0.15	0.12	0.39	0.18	0.48	0.64	0.4	0.31	0.3

7	0.06	0.21	0.15	0.12	0.39	0.18	0.48	0.64	0.4	0.31	0.3

Stock in numbers (thousands) estimated by age and year

age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	3930	3419	3266	2435	2261	2465	2406	1700	1041	882	1447
2	2059	2432	2116	2021	1507	1393	1520	1407	1045	639	546
3	1081	1401	1570	1437	1380	960	928	846	908	632	422
4	489	686	773	1059	849	647	620	384	508	483	365
5	215	336	316	473	509	336	403	283	220	272	234
6	63	151	179	174	264	235	197	167	93	111	153
7	76	836	1212	788	184	526	405	342	114	114	142

Method 2- (XSA – sex combined)

Using the FLR libraries (Kell et al. 2007) an Extended Survivors Analysis (XSA – Darby and Flatman, 1994) was carried out to assess trends in fishing mortality, stock biomass, spawning stock biomass, and recruitment of *Nephrops norvegicus* in the GSA 11. The XSA analysis was carried out for sex combined. The time series considered was of 11 years (2005-2015).

Input data

By applying a knife slicing procedure to the DCF official data on landings at length, landings at age were derived and used together with total catches as input data for the XSA. Standardized abundance by length from MEDITS survey were split and used for tuning. The growth parameters for sex combined (section 6.10.1.1, Table 6.10.1.1.1) were used to split the length data. After age slicing a plus group (7+) was derived. The new combined sex growth parameters resulted in slightly different average growth rates and thus a slightly different catch at age matrix compared with the sex separated method. The resulting SoP were slightly different and similar to the sex separated assessment they were corrected (SOP = Landings / Σx_a (x_a= product of catch numbers at age and weight-at-age)). The SOP correction factor is given in the following Table 6.10.2.6.

Table 6.10.2.6. Norway lobster in GSA 11. SOP correction factor applied to the catch at age matrix.

year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
SOP factor	1.093	1.089	1.129	1.068	1.116	1.105	1.075	1.067	1.088	1.096	1.078

The proportion at age shows that catches are concentrated on ages 2-5 (Figure 6.10.2.7).

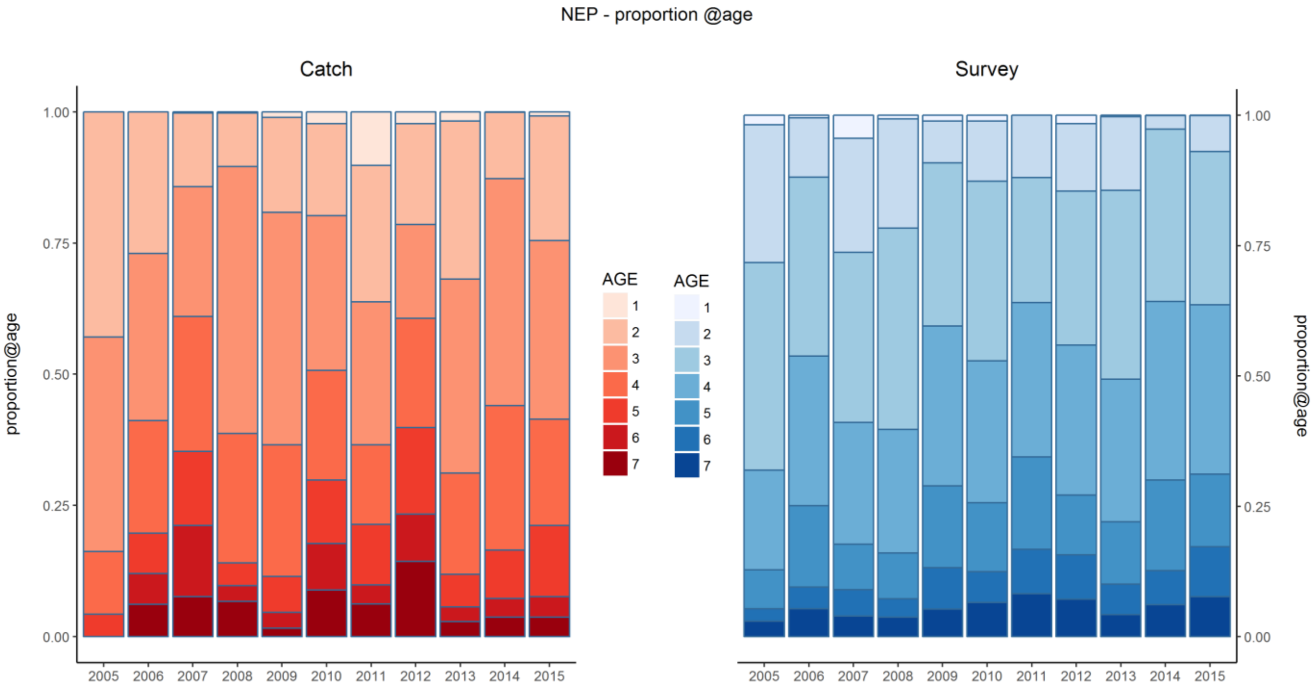
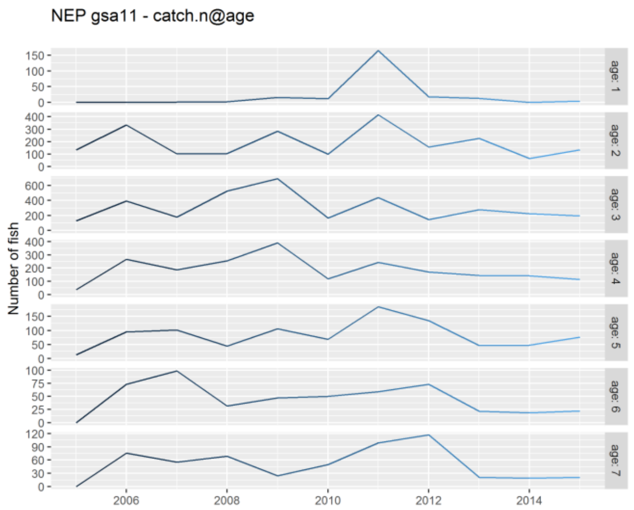
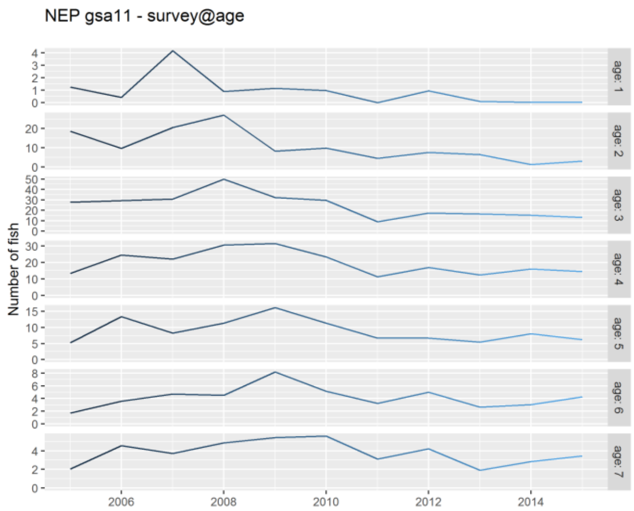


Figure 6.10.2.7. Norway lobster in GSA 11. Proportion at age of catch and tuning data by year.

The trends of catches at ages shows that catches shows a decreasing pattern from 2011 for all ages (Figure 6.10.2.8 a). In MEDITS the decreasing trend starts earlier (Figure 6.10.2.8 b).



a



b

Figure 6.10.2.8. Norway lobster in GSA 11. Trend of catch at age for landings (a) and survey data (b).

To be consistent with the growth parameter used to split the length data, also the maturity vector used for the assessment was adopted from that reported for GSA9. A natural mortality vector computed using ProdBiom (Abella, 1998) was used. All the input parameters (landings, catch number at age, weight at age, maturity at age, natural mortality at age and the tuning series at age) used in the XSA were listed below (Table 6.10.2.7).

Table 6.10.2.7. Norway lobster in GSA 11. Input parameters used for the XSA.

TUNING
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MEDITS

age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	1.3	0.4	4.2	0.9	1.2	1	0	1	0.1	0	0
2	18.5	9.8	20.6	27	8.2	9.9	4.5	7.6	6.4	1.2	3.1
3	27.9	29.4	30.7	49.8	32.2	29.6	9.1	17.3	16.5	15.4	13.2
4	13.4	24.6	22	30.5	31.6	23.4	11.2	16.9	12.5	15.9	14.5
5	5.2	13.4	8.2	11.3	16.2	11.3	6.7	6.7	5.5	8.1	6.2
6	1.7	3.6	4.7	4.5	8.2	5.1	3.2	5	2.7	3	4.3
7	2.1	4.6	3.7	4.9	5.4	5.6	3.1	4.2	1.9	2.8	3.4

initial settings

min	max	plusgroup	minyear	maxyear	minfbar	maxfbar
1	7	7	2005	2015	2	6

Mortality and Maturity vectors@age

	1	2	3	4	5	6	7
maturity	0.1	0.25	0.5	0.8	1	1	1
mortality	0.48	0.36	0.3	0.27	0.26	0.24	0.23

Mean Weight@age (kg) in stock, catch, landings

age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	0	0	0	0	0	0	0	0.01	0	0	0.01
2	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
3	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
4	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
5	0.05	0.06	0.06	0.06	0.05	0.06	0.05	0.05	0.05	0.05	0.06
6	0.07	0.07	0.07	0.08	0.07	0.07	0.07	0.08	0.08	0.07	0.07
7	0.13	0.13	0.11	0.13	0.11	0.12	0.13	0.15	0.12	0.12	0.11

catch in weight (ton) by year

age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
all	6.29	42.3	31.3	36.2	44.4	22.8	50.5	41.1	20.6	17.2	18.2

Catch at age matrix (numbers in thousands)

age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	0	0	1	2	16	13	164	18	13	0	4
2	133	335	102	105	283	99	416	157	227	65	135
3	127	394	180	525	690	166	437	147	278	224	193
4	37	267	187	255	392	118	244	170	145	143	115
5	13	95	102	44	106	68	184	135	47	48	77
6	0	73	99	32	47	50	59	73	22	19	22
7	0	76	55	69	25	50	99	117	21	19	21

Results

A sensitivity analysis was performed to select the most suitable parameters to be used in the XSA in terms of minimizations of residuals. Using all the parameters combination of rage (0 to 1, step of 1), qage (1 to 5, step of 1), shk.ages (1 to 3, step of 1) and fse (0.5 to 3, step of 0.5) a total of 180 different XSA runs were carried out and outputs in term of residual were evaluated. Residuals range from -9.26 to 3.28e+04 (1st quartile -0.13, interquartile range 0.62). Means calculated on the absolute value of residuals (mean_absres) for each run range from 0.18 to 5.012e+3 (mean 7.8, 1st quartile 0.42, interquartile range 2.18).

To choose the best setting among all 180 runs we preselect only those runs showing the lower mean_absres, and a diagnostic analysis of retrospective performances was carried out on them. As a criteria of selection for progress in the sensitive analysis the run with mean_absres lower than the first quartile (0.42) were chosen (n=34, Table 6.10.2.8, Figure 6.10.2.9).

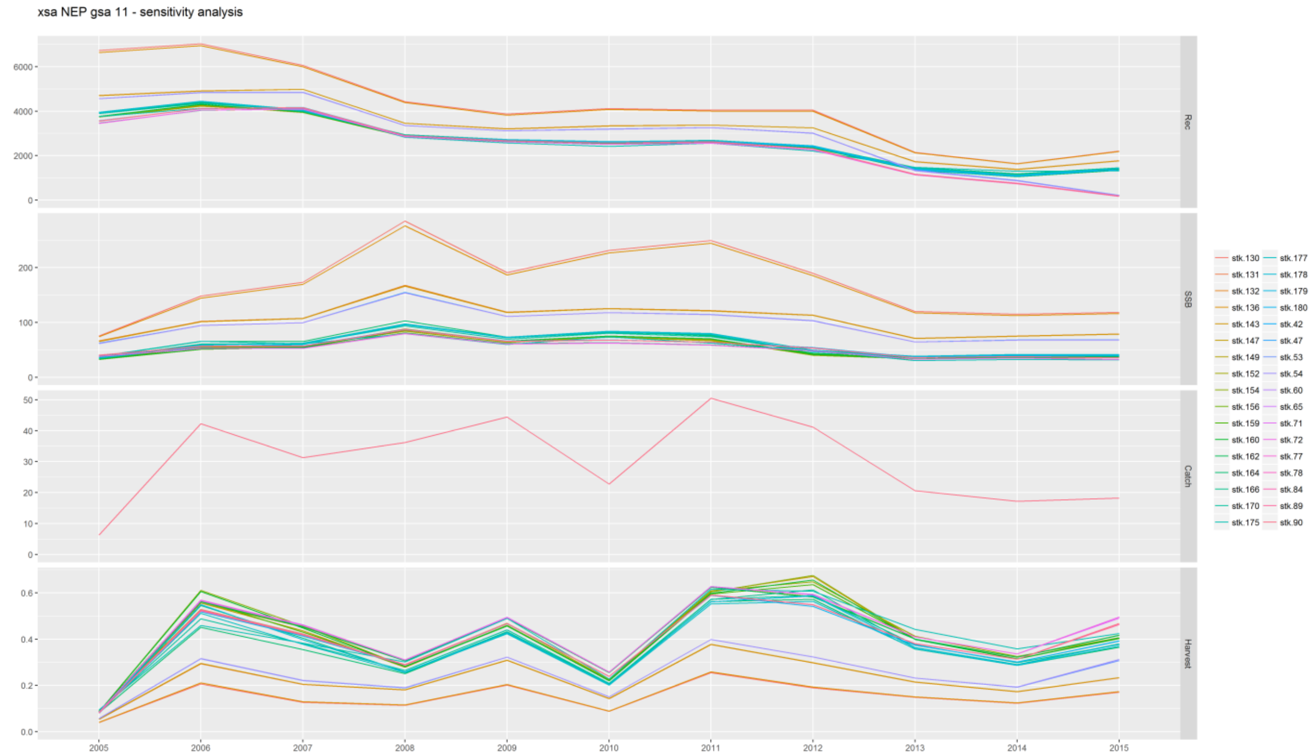


Figure 6.10.2.9. Norway lobster in GSA 11. Sensitivity analyses of all the preselected XSA runs (n=34).

Table 6.10.2.8. Norway lobster in GSA 11. Settings for the sensitivity analysis and min, max and mean values of absolute residuals for all the preselected runs (n=34).

run_n	setsens	shkage	fse	rage	qage	minres	maxres	absmean	absmax
180	sh3se3r1q5	sh3	se3	r1	q5	-1.233	0.729	0.184	1.233
162	sh3se3r1q4	sh3	se3	r1	q4	-1.237	0.721	0.184	1.237
179	sh3se2.5r1q5	sh3	se2.5	r1	q5	-1.236	0.730	0.184	1.236
149	sh1se2.5r1q4	sh1	se2.5	r1	q4	-1.240	0.723	0.185	1.240
156	sh2se3r1q4	sh2	se3	r1	q4	-1.237	1.000	0.199	1.237
132	sh1se3r1q3	sh1	se3	r1	q3	-1.215	0.805	0.225	1.215
131	sh1se2.5r1q3	sh1	se2.5	r1	q3	-1.219	0.807	0.226	1.219
84	sh2se3r0q5	sh2	se3	r0	q5	-1.520	1.425	0.288	1.520
78	sh1se3r0q5	sh1	se3	r0	q5	-1.520	1.425	0.288	1.520
60	sh1se3r0q4	sh1	se3	r0	q4	-1.522	1.422	0.288	1.522
90	sh3se3r0q5	sh3	se3	r0	q5	-1.520	1.425	0.289	1.520
89	sh3se2.5r0q5	sh3	se2.5	r0	q5	-1.533	1.435	0.290	1.533
77	sh1se2.5r0q5	sh1	se2.5	r0	q5	-1.533	1.437	0.290	1.533
71	sh3se2.5r0q4	sh3	se2.5	r0	q4	-1.534	1.432	0.290	1.534
65	sh2se2.5r0q4	sh2	se2.5	r0	q4	-1.534	1.432	0.290	1.534
72	sh3se3r0q4	sh3	se3	r0	q4	-1.522	1.421	0.306	1.522
42	sh1se3r0q3	sh1	se3	r0	q3	-1.494	1.453	0.324	1.494
53	sh3se2.5r0q3	sh3	se2.5	r0	q3	-1.506	1.463	0.327	1.506
47	sh2se2.5r0q3	sh2	se2.5	r0	q3	-1.506	1.464	0.332	1.506
166	sh1se2r1q5	sh1	se2	r1	q5	-1.235	9.488	0.339	9.488
178	sh3se2r1q5	sh3	se2	r1	q5	-1.234	9.737	0.341	9.737
154	sh2se2r1q4	sh2	se2	r1	q4	-1.242	9.361	0.355	9.361

run_n	setsens	shkage	fse	rage	qage	minres	maxres	absmean	absmax
160	sh3se2r1q4	sh3	se2	r1	q4	-1.242	9.612	0.357	9.612
147	sh1se1.5r1q4	sh1	se1.5	r1	q4	-1.252	11.074	0.361	11.074
177	sh3se1.5r1q5	sh3	se1.5	r1	q5	-1.243	11.431	0.361	11.431
164	sh1se1r1q5	sh1	se1	r1	q5	-1.265	11.984	0.370	11.984
170	sh2se1r1q5	sh2	se1	r1	q5	-1.267	12.030	0.370	12.030
143	sh3se2.5r1q3	sh3	se2.5	r1	q3	-1.219	9.882	0.376	9.882
159	sh3se1.5r1q4	sh3	se1.5	r1	q4	-1.251	11.313	0.378	11.313
152	sh2se1r1q4	sh2	se1	r1	q4	-1.273	11.937	0.385	11.937
136	sh2se2r1q3	sh2	se2	r1	q3	-1.203	9.700	0.398	9.700
130	sh1se2r1q3	sh1	se2	r1	q3	-1.200	9.755	0.401	9.755
54	sh3se3r0q3	sh3	se3	r0	q3	-1.494	6.030	0.415	6.030
175	sh3se0.5r1q5	sh3	se0.5	r1	q5	-1.316	12.574	0.418	12.574

The best retrospective performance was shown by the run number 180 (Figure 6.10.2.10).The recruitment estimation shows a decreasing trend but looks instable. A better pattern was observed in the retrospective analysis of fishing mortality which was more stable, showing a decreasing trend until 2014 and a weak increase of F in the last year (2015).

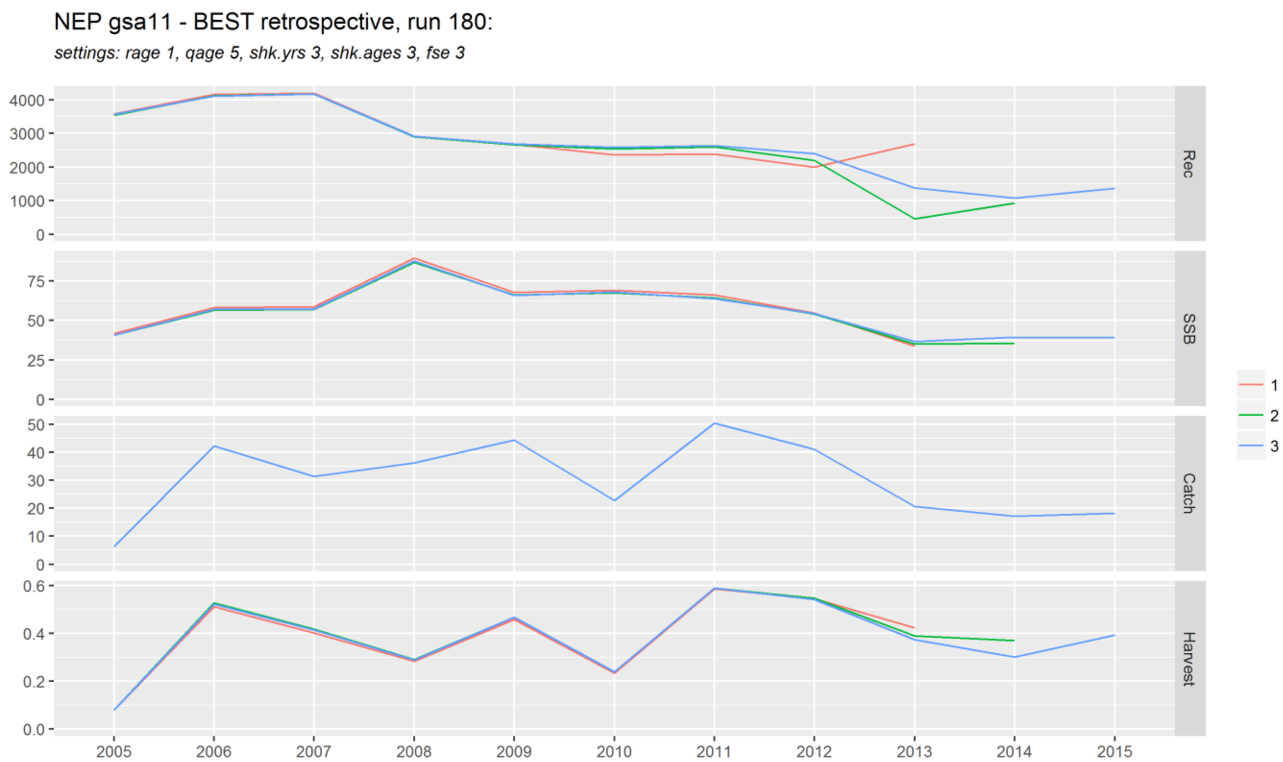


Figure 6.10.2.10. Norway lobster in GSA 11. Retrospective analyses of the best XSA run.

The diagnostic analysis of the residuals for the best XSA runs show low values in the residuals and was considered acceptable, but shows an year effect on residuals for 2011 (Figure 6.10.2.11, Table 6.10.2.9).

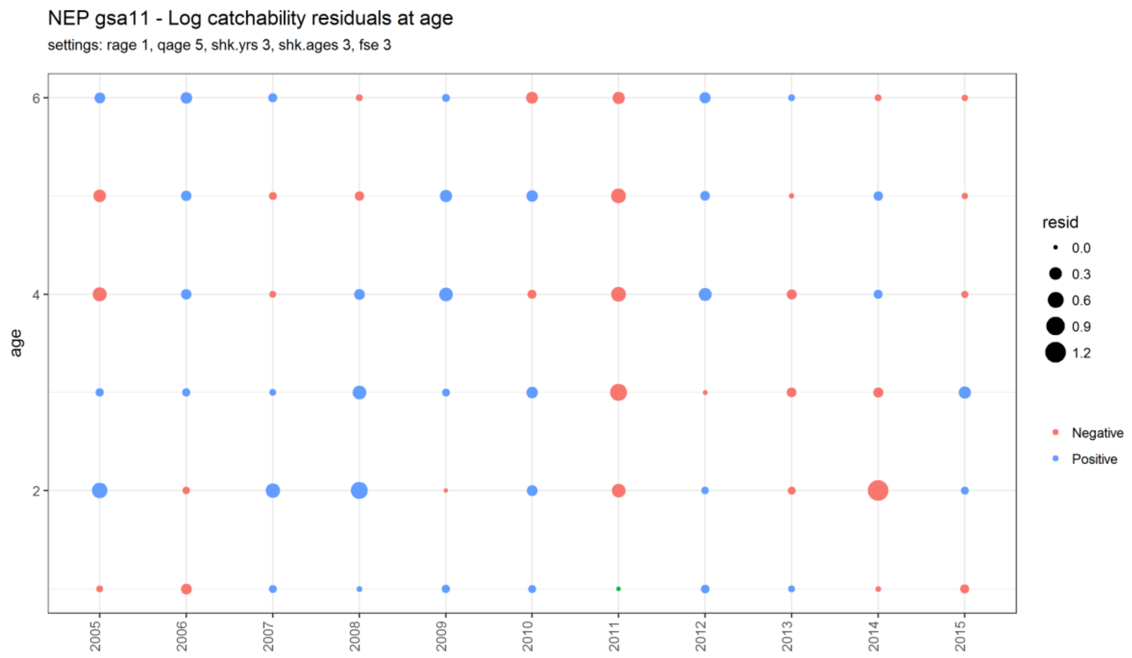


Figure 6.10.2.11. Norway lobster in GSA 11. Bubble plots of residuals of XSA compared to MEDITS.

Table 6.10.2.9. Norway lobster in GSA 11. Log-catchability residuals of XSA.

Log catchability residuals of XSA

Age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	-0.02	-0.19	0.06	0.01	0.06	0.05	0.00	0.08	0.03	-0.01	-0.10
2	0.58	-0.04	0.47	0.73	0.00	0.19	-0.38	0.04	-0.05	-1.23	0.05
3	0.07	0.07	0.03	0.38	0.05	0.22	-0.74	0.00	-0.12	-0.14	0.27
4	-0.43	0.17	-0.02	0.18	0.41	-0.10	-0.50	0.32	-0.15	0.09	-0.03
5	-0.32	0.16	-0.06	-0.11	0.29	0.24	-0.50	0.12	0.00	0.12	-0.01
6	0.19	0.22	0.09	-0.02	0.05	-0.25	-0.28	0.20	0.03	-0.02	-0.02

The XSA results show a decreasing trend in recruitment and fishing mortality (F2-6) in the last years with a weak increase in 2015. The estimated F_{curr} was 0.39 (Figure 6.10.2.12, Table 6.10.2.10).

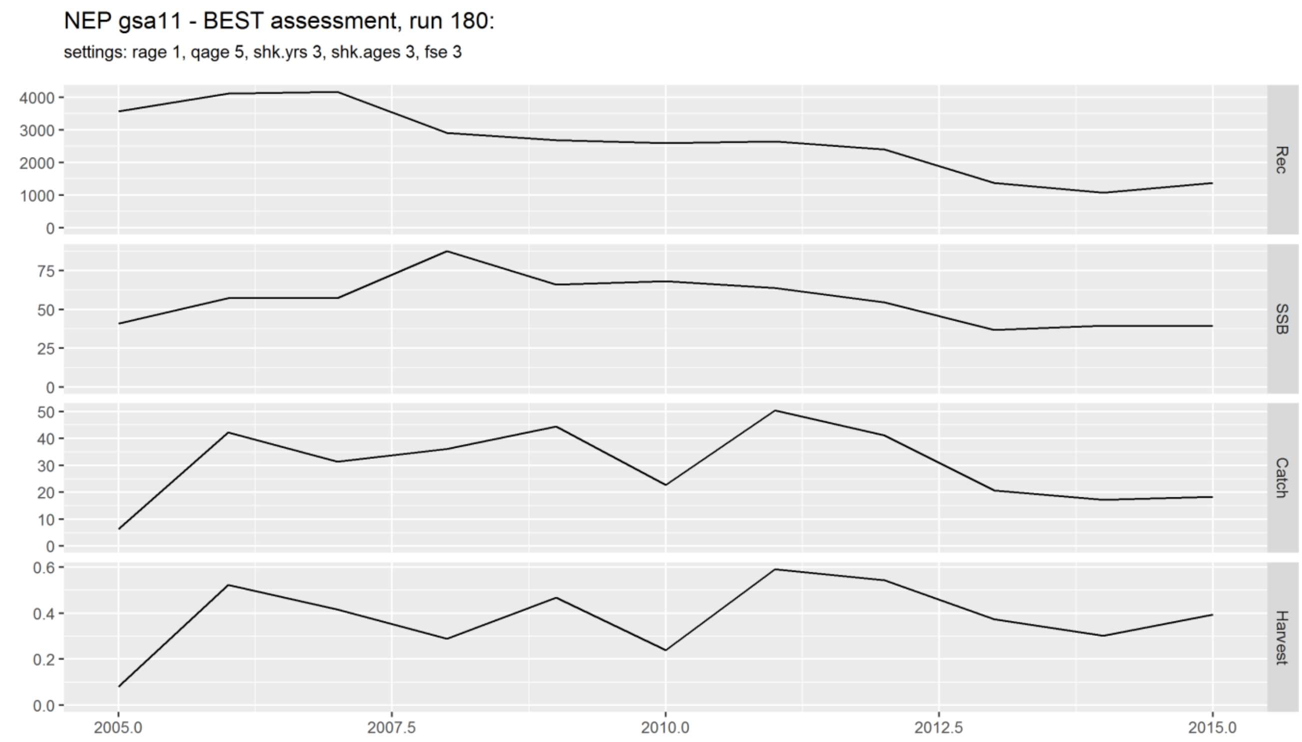


Figure 6.10.2.12. Norway lobster in GSA 11. XSA summary results. SSB and catch are in tons, recruitment in 1000s individuals.

Table 6.10.2.10. Norway lobster in GSA 11. XSA summary, fishing mortality and stock in numbers (thousands).

XSA summary

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
ssb	40.8	57.1	57.3	87.7	66.1	68.2	63.9	54.4	36.7	39.5	39.1
fbar	0.08	0.52	0.41	0.29	0.47	0.24	0.59	0.54	0.37	0.3	0.39
rec	3567	4110	4169	2910	2681	2591	2641	2403	1373	1075	1372
catch	6.3	42.3	31.3	36.2	44.4	22.8	50.5	41.1	20.6	17.2	18.2

Fishing mortality by year estimated with XSA

age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	0	0	0	0	0.01	0.01	0.08	0.01	0.01	0	0
2	0.08	0.2	0.05	0.05	0.21	0.07	0.38	0.13	0.2	0.1	0.28
3	0.15	0.42	0.18	0.45	0.63	0.21	0.65	0.25	0.43	0.37	0.55
4	0.09	0.59	0.4	0.47	0.82	0.22	0.61	0.64	0.47	0.46	0.37
5	0.09	0.37	0.52	0.16	0.39	0.34	0.71	0.93	0.38	0.3	0.53
6	0	1.03	0.93	0.31	0.28	0.34	0.6	0.76	0.38	0.27	0.24
7	0	1.03	0.93	0.31	0.28	0.34	0.6	0.76	0.38	0.27	0.24

Stock in numbers (thousands) estimated by age and year

age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	3567	4110	4169	2910	2681	2591	2641	2403	1373	1075	1372
2	2082	2207	2543	2579	1799	1647	1593	1505	1472	840	665
3	1071	1342	1260	1689	1711	1019	1066	764	919	838	531

4	496	684	654	779	799	674	612	414	440	441	427
5	181	346	289	336	372	267	412	254	167	209	212
6	33	128	184	133	220	194	146	155	78	88	119
7	33	130	101	289	114	193	243	244	75	89	110

Comparison with Combined and separate sex assessments

The perception of SSB and F are very similar for the two assessments with the important differences only occurring prior to 2009. The assumptions that were made to create the two sex model and the number of extra parameters needed did not justify the added information, particularly as female growth was unknown and had to be assumed. Thus the single sex assessment is chosen for advice.

Method 2. Length-based analysis

Length-based methods were used for deriving some indicators explored in WKLIFE IV. (ICES, 2015). They allow classifying the stocks according to conservation/sustainability, yield optimization and MSY considerations. Analysis required data on the stock catch/landings–length composition and life-history parameters as Linf.
The length-based indicators analysis was performed using the commercial landings in 2013to 2015 (discards considered negligible) and the following life-history parameters: Linf=74.1 mm.

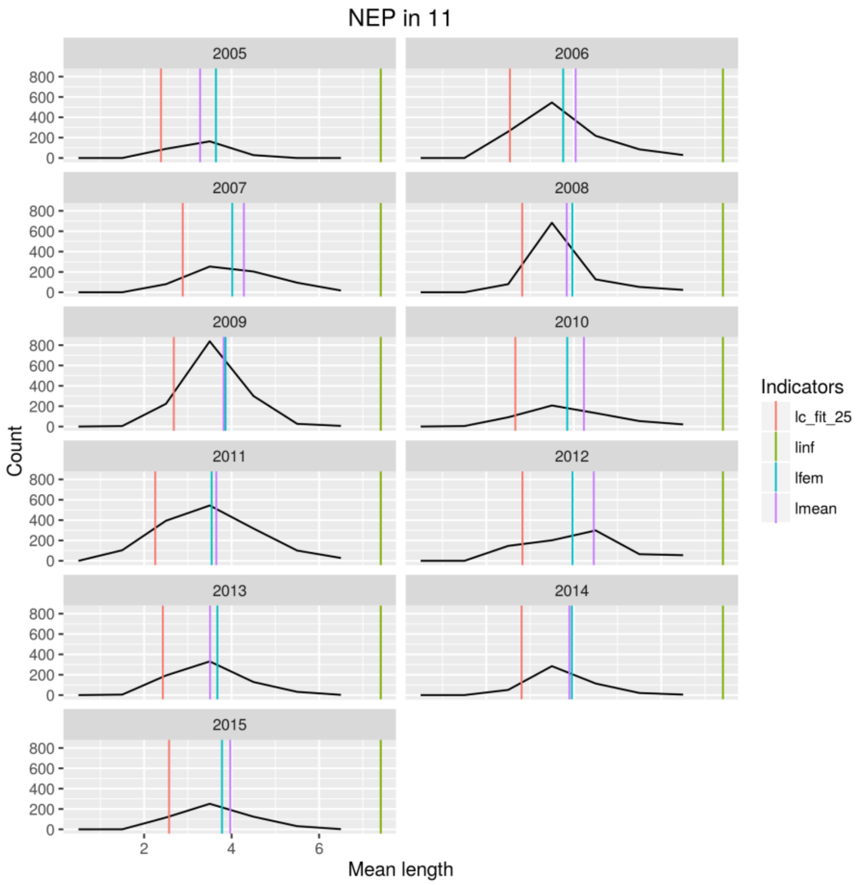


Figure 6.10.2.13. Norway Lobster in GSA 11. Length-based indicators and reference points for Norway lobster using the catch length composition for 2005, to 2015

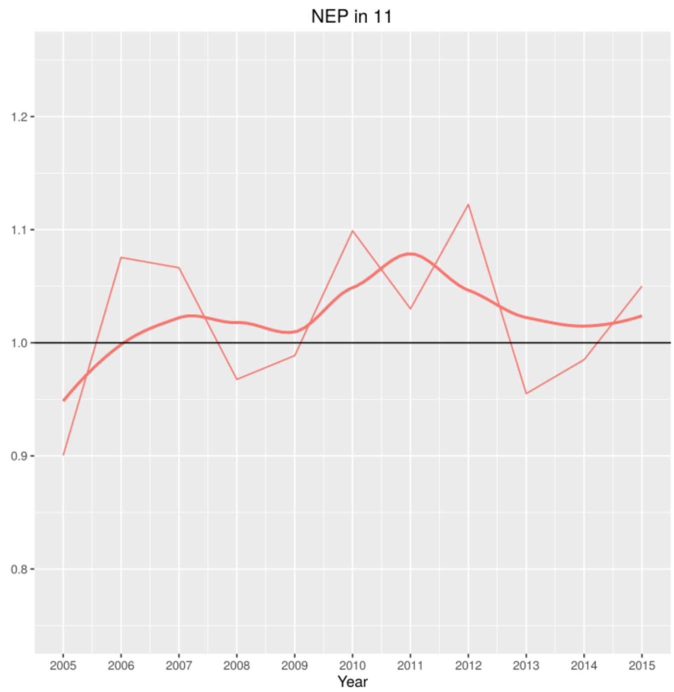


Figure 6.10.2.14. Norway Lobster in GSA 11. Length-based indicator for Norway lobster using the catch length composition for 2005 to 2015

The overall perception from length-based indicators is that the stock is currently being fished close to or just below the MSY level. The is not in agreement with the assessment, though the MSY reference point based on F0.1 may be conservative in order to include biomass considerations not included in the length analysis. He trend showing reduced expiation over time is in agreement with the XSA assessments.

6.10.3 REFERENCE POINT

The time series of SSB and R values is not sufficient to allow evaluation of S-R elements of MSY, so the WG has applied the STECF recommended method of F0.1. Using the FLR libraries (Kell et al. 2007) a yield per recruit (YpR) analysis was conducted assuming equilibrium conditions and having as a base the exploitation pattern resulted from the XSA analysis of *Nephrops norvegicus* in the GSA 11. YPR was used for the estimation of $F_{0.1}$.

As a result of the analysis by sex combined the F_{curr} (0.35) (mean 2013-2015) is larger than $F_{0.1}$ (0.19), chosen as proxy of FMSY and as the exploitation reference point consistent with high long term yields, which indicates that Norway lobster in GSA 11 is exploited above FMSY.

6.10.4 SHORT TERM FORECAST

A deterministic short term prediction for the period 2015 to 2017 was performed using the FLR routines provided by JRC and based on the results of the XSA stock assessments performed during EWG 16-17 (Figure 6.10.4.1, Table 6.10.4.1).

The input parameters were the same used for the XSA and its stock assessment results. An average of the last three years has been used for weight at age, maturity at age and F at age.

Recruitment has been estimated from the population results as the geometric mean of the last 3 years (1265 thousand individuals).

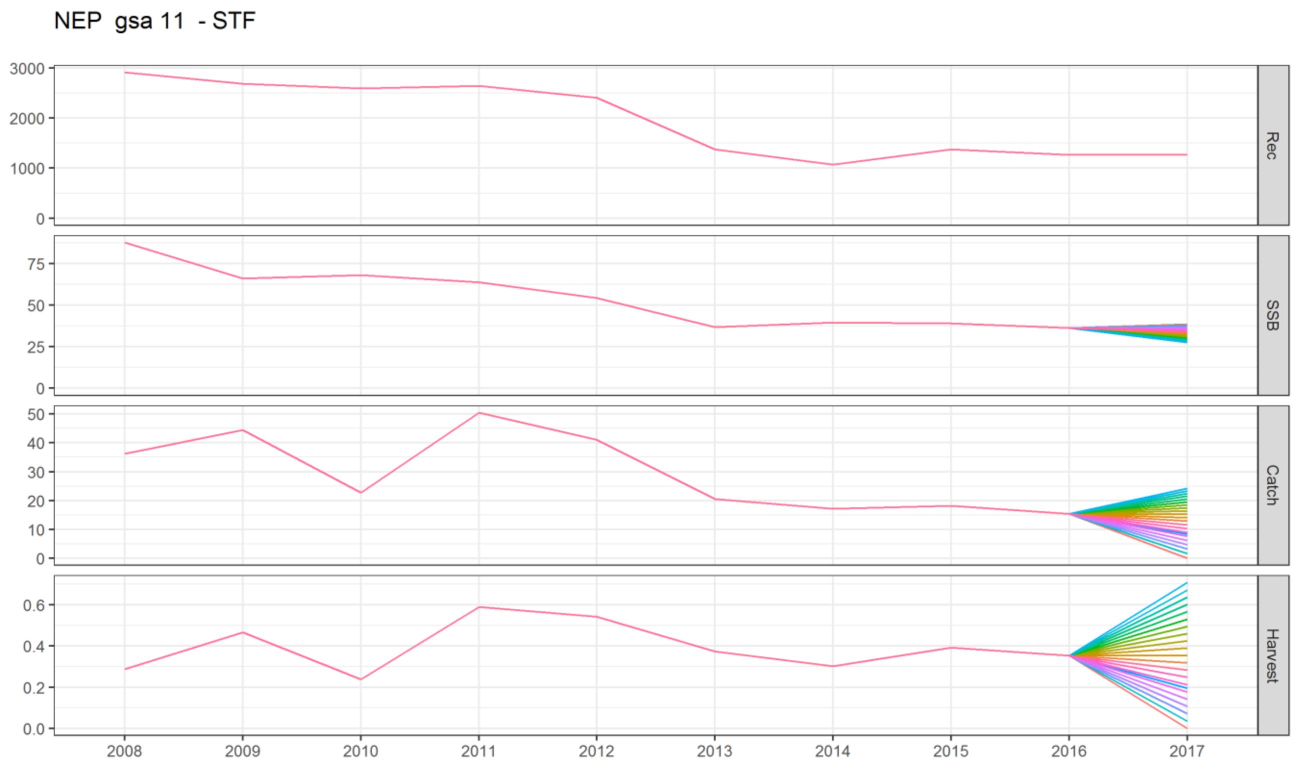


Figure 6.10.4.1. Norway lobster in GSA 11. Short term forecast in different F scenarios.

Table 6.10.4.1. Norway lobster in GSA 11. Short term forecast in different F scenarios. Based on three year average natural mortality, growth and fishery selection and catches in 2016 = 15 t

Rationale	Ffactor	Fbar	Catch_2017	Catch_2018	SSB_2018	Change_SSB 2017-2018(%)	Change_Catch 2015-2017(%)
Zero catch	0.0	0.00	0.0	0.0	49.1	28	-100
High long term yield (F0.1)	0.5	0.19	8.3	9.0	37.4	7	-54
Status quo	1.0	0.35	14.10	13.37	14.10	-8	-23
Different Scenarios	0.2	0.07	3.2	3.9	44.4	19	-82
	0.3	0.11	4.7	5.6	42.3	15	-74
	0.4	0.14	6.2	7.1	40.3	12	-66
	0.5	0.18	7.6	8.4	38.3	8	-58
	0.6	0.21	9.0	9.6	36.5	5	-51
	0.7	0.25	10.4	10.7	34.8	1	-43
	0.8	0.28	11.6	11.7	33.1	-2	-36
	0.9	0.32	12.9	12.6	31.6	-5	-29
	1.0	0.35	14.1	13.4	30.1	-8	-23
	1.1	0.39	15.3	14.1	28.7	-11	-16
	1.2	0.42	16.4	14.7	27.3	-13	-10
	1.3	0.46	17.5	15.2	26.1	-16	-4
	1.4	0.50	18.6	15.7	24.9	-19	2
	1.5	0.53	19.6	16.1	23.7	-21	7

	1.6	0.57	20.6	16.4	22.6	-23	13
	1.7	0.60	21.5	16.7	21.6	-26	18
	1.8	0.64	22.5	17.0	20.6	-28	23
	1.9	0.67	23.4	17.2	19.7	-30	28
	2.0	0.71	24.2	17.3	18.8	-32	33

6.10.5 QUALITY AND PROPOSALS FOR FUTURE ASSESSMENTS

Data on growth parameters of *N. norvegicus* in GSA 11 were only available for males and pertain to a long unique period (2005-2015). While it is well know that male and female exhibit different growth patterns, the provision of growth parameters by sex and shorter time periods, the sex ratios by length and year in the catches, would allow to carry out more accurate assessments in the future,

6.11 NORWAY LOBSTER IN GSAs 17 AND 18

6.11.1 DATA GATHERING OF NORWAY LOBSTER IN GSAs 17 AND 18

6.11.1.1 Stock Identity and Biology

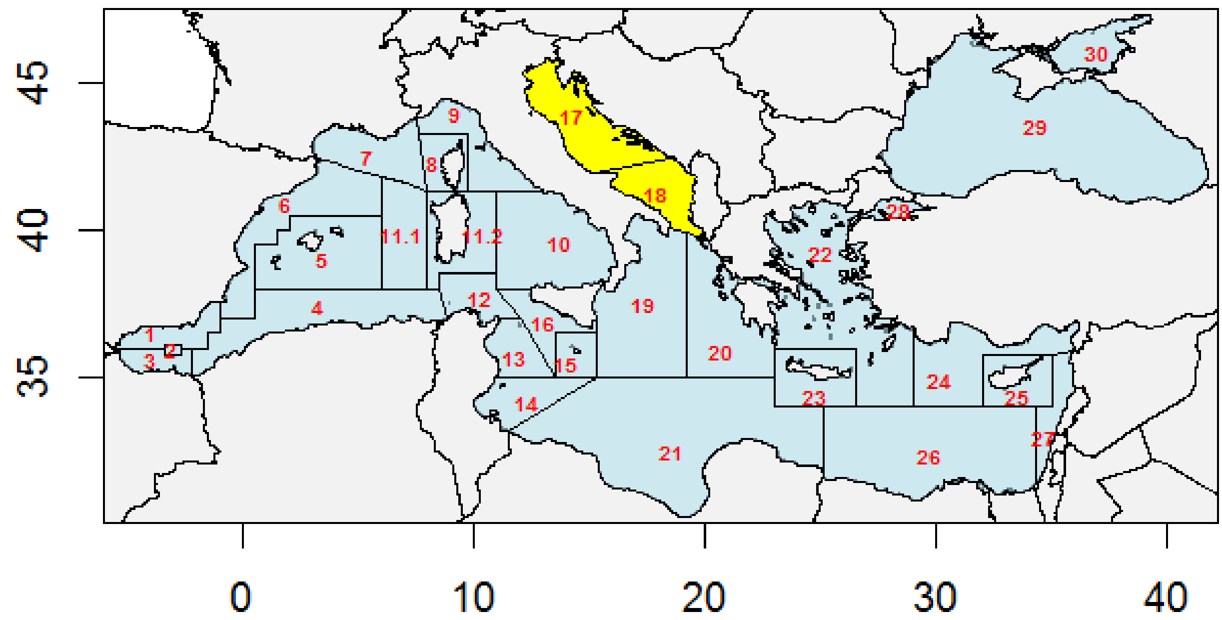


Figure 6.11.1.1.1. Geographical location of GSAs 17-18.

The main biological traits of the species in the Adriatic have been revised during EWG 15-16. One of the most relevant features pointed out is the occurrence of a sub-unit of individuals living in the Pomo-Jabuka Pit area, and featured by significant differences in the biological parameters (e.g. growth and maturity) in comparison with specimens distributed on the continental shelf of the GSA 17 (Froglia and Gramitto, 1988). EWG 15-16 discussed the implications of such spatial configuration for the assessment of the stock identifying as a pre-requisite the availability of

catch/landings data split by fishing grounds (Pomo Pit, continental shelf areas) to properly apply age-based models.
In GSA 18 the stock is basically distributed on the continental slope, deeper than 200m depth, both on the eastern (Montenegro, Albania) and western side (Italy, Puglia) of the GSA.
The distribution of nursery grounds and spawning areas has been analysed during the EU project MEDISEH (MAREA tender project). In GSA 17 denser and persistent patches of small specimens occur in the Pomo Pit area (MEDISEH project report, 2013). Aggregations of adults were identified in GSA 17 offshore the SW coasts, in the Pomo Pit, and in north and south Croatian waters (Figure 11.1.1.1.2). In GSA 18 the more persistently abundant adult aggregations occur on the SE and SW edges of the South Adriatic Pit (Figure 11.1.1.1.3).

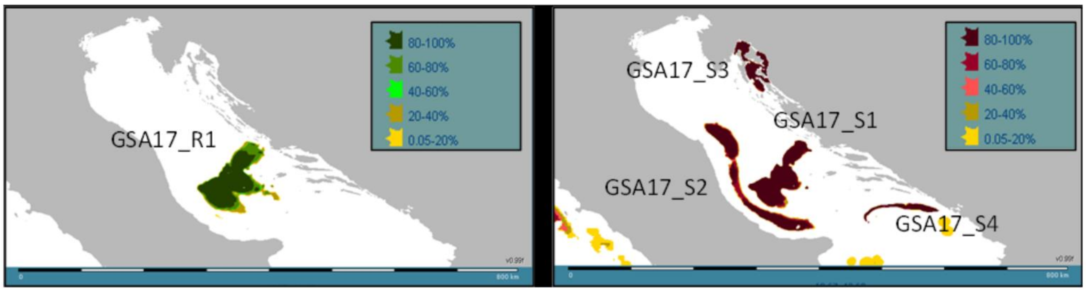


Figure 6.11.1.1.2. Norway lobster in GSA 17. Position of persistent nursery (left) and spawning areas (right) in GSA 17 as identified by the MEDISEH project (Mediterranean Sensitive Habitats, 2013).

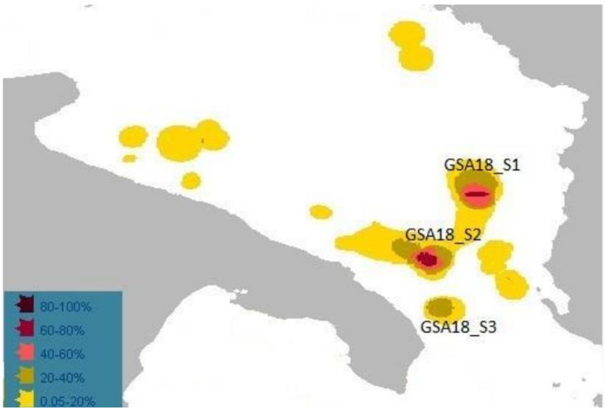


Figure 6.11.1.1.3. Norway lobster in GSA 18. Position of persistent spawning areas in GSA 18 of as identified by the MEDISEH project (Mediterranean Sensitive Habitats, 2013).

Growth

A summary of the knowledge on growth and maturity pattern of Norway lobster in Adriatic is provided in the EWG 15-16 report (STECF, 2015). A comparison of the growth curves for Norway lobster in GSAs 17 and 18 is showed in Figure 11.1.1.1.4 was done during EWG 16.17. Specimens in the Pomo area grow slower than the ones distributed on the Adriatic shelf (Ancona area, Froglia and Gramitto, 1988). Their growth pattern in the first 2-3 years appears similar to the growth estimated for specimens in GSA 18 in the same age range (Table 6.11.1.1.1.). This can be the result of similarity in the habitat where the species lives in these two areas, i.e. continental slope below 200m depth. In the Pomo Pit area the proportion of specimens over 40 mm CL appears very low as probably determined by a slow growth after the first 3-4 years. However, high mortality rate of adults and or dispersion/migration toward other areas cannot be excluded. In this regard, it would be important to explore the connectivity of the Pomo Pit sub-unit with the stock in GSA 18. The Pomo Pit system is in fact well connected with the South Adriatic slope through a narrow channel between 100 and 150 m.

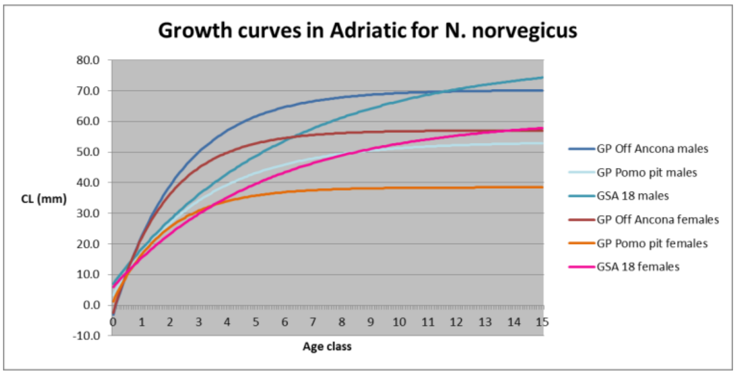


Figure 6.11.1.1.4. Norway lobster in GSAs 17 and 18. Growth curves of males and females of Norway lobster in GSAs 17 and 18.

Table 6.11.1.1.1. Norway lobster in GSAs 17 and 18. Length at age of Norway lobster in different Adriatic areas (i.e. Pomo Pit, offshore Ancona, South Adriatic)

age class	GP Off Ancona males	GP Off Ancona females	GP Pomo pit males	GP Pomo pit females	GSA 18 males	GSA 18 females
0	-0.5	0.1	4.6	2.9	8.1	6.8
1	22.5	22.0	17.0	16.6	18.4	15.5
2	39.2	36.4	26.9	25.6	28.1	23.4
3	50.1	44.9	34.2	30.9	36.2	29.9
4	57.1	49.9	39.4	34.0	43.0	35.3
5	61.7	52.8	43.2	35.8	48.8	39.7
6	64.7	54.6	46.0	36.9	53.7	43.4
7	66.6	55.6	48.0	37.6	57.8	46.4

Maturity

Maturity size of females from available studies in GSAs 17 and 18 are reported in Table 6.11.1.1.1.2.

Table 6.11.1.1.1.2. Norway lobster in GSAs 17 and 18. Length-at-maturity information on Norway lobster females from studies carried out in Adriatic Sea (from EWG 15-16 report).

- GSA 17 – Pomo Pit: ~ 26 mm CL (Froglia and Gramitto, 1979; Gramitto and Froglia, 1980; Froglia and Gramitto, 1981; IMBC et al., 1994; Orsi Relini et al., 1998; DCF data);
- GSA 17 – outside Pomo Pit: ~30 – 32.5 mm CL (Froglia and Gramitto, 1979; Gramitto and Froglia, 1980; Froglia and Gramitto, 1981; IMBC et al., 1994; Orsi Relini et al., 1998);
- GSA 18: between 25 mm and 34.8 mm CL, depending on the year (Marano et al., 1998a; Ungaro et al., 1999; DCF data).

Maturity ogives provided with the data call and available during EWG16-17 are showed in Figure 6.11.1.1.1.5. and Figure 6.11.1.1.1.6. L50 was estimated on the proportion of mature specimens using binomial GLM. In GSA 17, L50 of females ranged between 21.2 and 25.6 mm CL in Croatian waters in 2013-2015 and it was 30.4 mm CL on the Italian side in 2015. Such differences might be related to differences in the approach followed to select the “mature” individuals more than real differences in the maturity process. In GSA 18, L50 was 23.5 mm CL for females and 25.6 mm CL in 2007-2014 and 24.4 mm CL in 2015 (sex combined, Figure cc).

According to the different growth curves hypothesized in the region and shown in Figure 6.11.1.1.3 females would achieve the maturity between 1 and 2 years old in the Italian side of the GSA 17, and at age 2 in GSA 18.

Maturity data for the Pomo Pit sub-unit seems more in line with the pattern observed for Norway lobster in GSA 18, thus supporting the hypothesis of similarity in biological features between the species in these two areas.

GSA 17

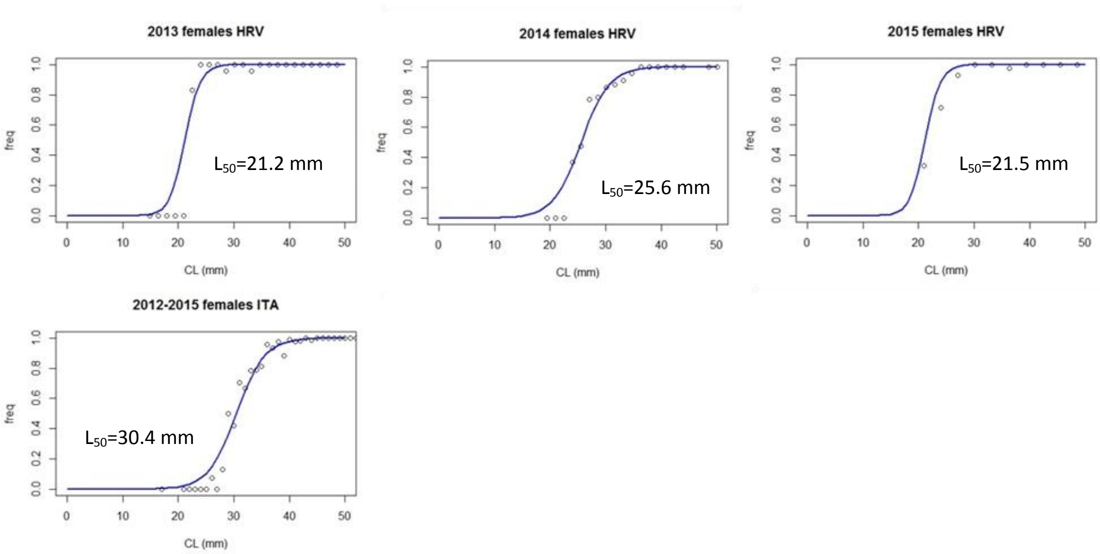


Figure 6.11.1.1.1.5. Norway lobster in GSA 17. Maturity ogives and length at first maturity (L_{50}) of females in Croatian and Italian waters (maturity data from data call).

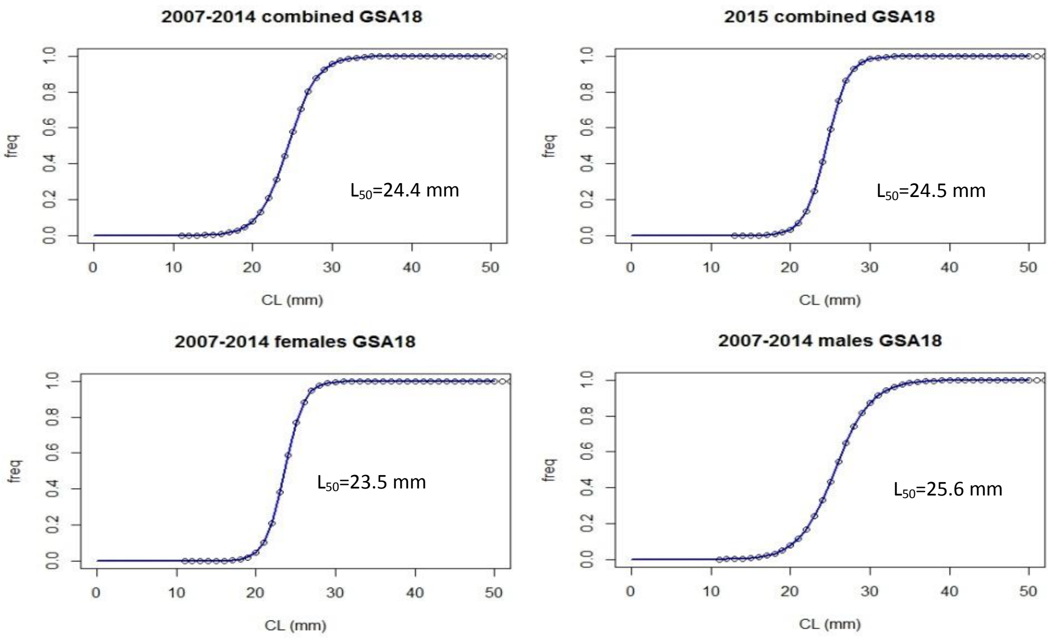


Figure 6.11.1.1.1.6. Norway lobster in GSA 18. Maturity ogives and length at first maturity (L_{50}) of females, males and sex combined (maturity data from data call).

6.11.1.2 Catch data

The minimum landing size of Norway lobster is 20 mm carapace length or 70 mm total length. Trawl net cod end mesh size 40 mm (stretched) diamond meshes or a cod end with 50 mm (stretched) square meshes. Towed gears are not allowed within three nautical miles from the coast or at depths less than 50 m when this depth is reached at a distance less than 3 miles from the coast. In GSA 17, since 26 July 2015 an area corresponding to the Pomo/Jabuka pithas been closed to all trawling fisheries (otter trawling, pair otter trawling and beam trawling) for a period of one year, until 26 July 2016. This closure was decided among all countries exploiting this area, mainly Italy and Croatia.

Landings

Data by gear for Croatia were available for the period 2013-2015. Data from 2008-2012 were obtained from the STECF EWG report 16-08 (Table 6.11.1.2.1).

Table 6.11.1.2.1. Norway lobster in GSAs 17. Landings data by gear for the period 2006-2013. Landings of Croatian fleets for the period 2008-2012 (in italics) were obtained from the report of STECF EWG 15-16 (Table 5.2.6.5.3.1.)

	GSA 17				GSA 18			
Fleet	HRV OTB	HRV FPO	ITA OTB	TOT	ITA OTB	ITA GNS	ITA NA	TOT
2002					442.2		36.3	478.5
2003					1039.3	5.5	141.8	1186.5
2004					1218.4			1218.4
2005					1196.4	2.3		1198.7
2006			1462		1436.6	9.6	0.5	1446.6
2007			1259		1299.9	14.7		1314.6
2008	*324.0*	*23.0*	1270	1617	1003.0	9.8		1012.8
2009	*342.0*	*23.0*	1379	1744	1092.9			1092.9
2010	*305.0*	*19.0*	1216	1540	1023.4			1023.4
2011	*260.0*	*20.0*	937	1217	759.2			759.2
2012	*228.0*	*17.0*	802	1047	458.7			458.7
2013	278.2	21.0	607	906	833.8			833.8
2014	325.2	14.7	529	869	444.7			444.7
2015	268.7	0.25	450	719	442.8			442.8

Annual landings of Italian trawlers in GSA 17 and 18 showed a similar and steep reduction since 2006. The current landings decreased from about 1400 t in 2006 to the current 450 t in both GSAs. The Croatian landings fluctuated between 200 and 350 t between 2008 and 2015 (Figure 6.11.1.2.1). Annual landings of Croatian traps was between 14 and 23 t with a very low value (0.25 t) reported for 2015 (Table 6.11.1.2.1).

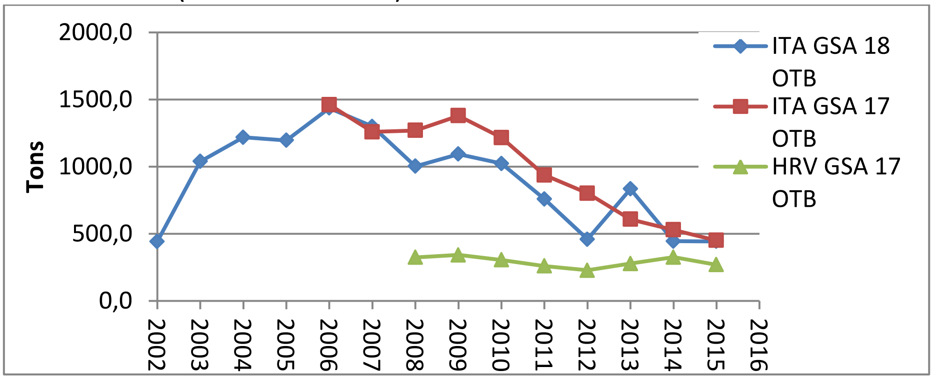


Figure 6.11.1.2.1. Norway lobster in GSA 17 and 18. Landings of the Italian and Croatian trawl fleets.

Size distributions of the landings

Length frequency distributions for trawlers in GSA 17 were available for the period 2006-2017. A peak in the landings was observed in 2006, mostly due to specimens below 30 mm, thus corresponding to a peak in recruitment. In the following years the landings composition shift toward larger sizes (Figure 6.11.1.2.2). Croatian data are available for two fleets segments, trawlers for the period 2013-2015 and traps (FPO) for 2014-2015 (Figure 6.11.1.2.3 and Figure 6.11.1.2.4). Length frequency distributions for Croatian OTB and FPO were provided as total length (TL) and converted into carapace length (CL) using the following equations (Froglia and Gramitto, 1988):

Off Ancona, Males	CL = 0.3146 TL - 0.8587	(r = 0.997 N = 287)
Off Ancona, Females	CL = 0.3055 TL - 0.3756	(r = 0.997 N = 249)

OTB length frequency distributions of GSA 18 are showed in Figure 6.11.1.2.5.

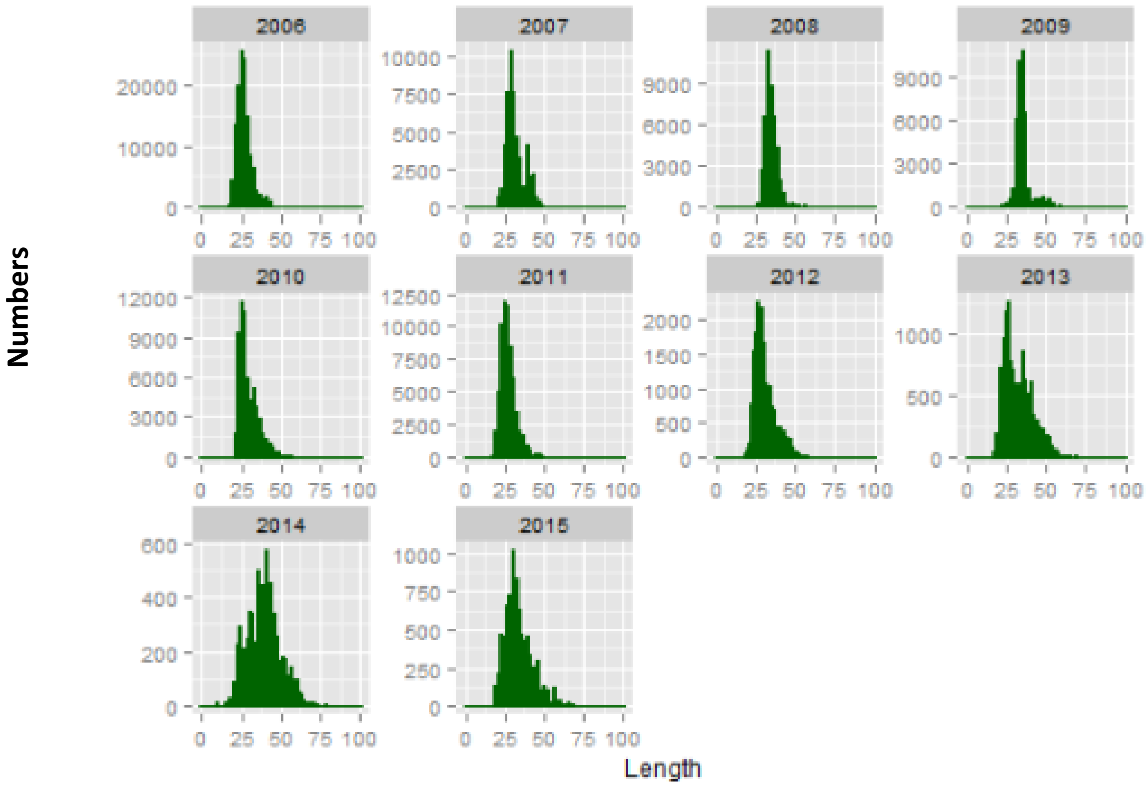


Figure 6.11.1.2.2. Norway lobster in GSA 17. Length frequency distribution of the Italian trawlers in the period 2006-2015.

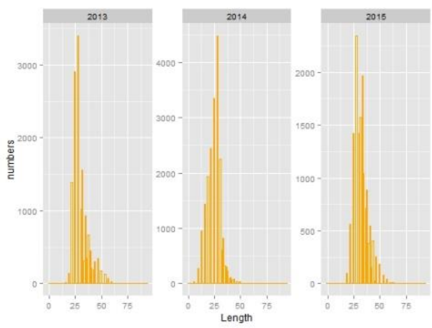


Figure 6.11.1.2.3. Norway lobster in GSA 17. Length frequency distribution of the Croatian trawlers in the period 2013-2015.

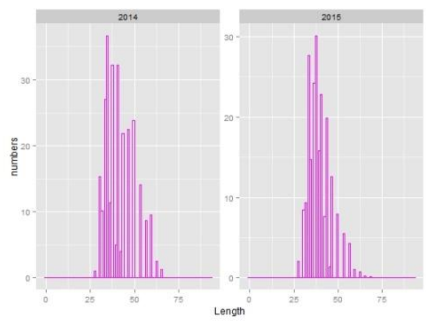


Figure 6.11.1.2.4. Norway lobster in GSA 17. Length frequency distribution of the Croatian traps (FPO) in the period 2013-2015.

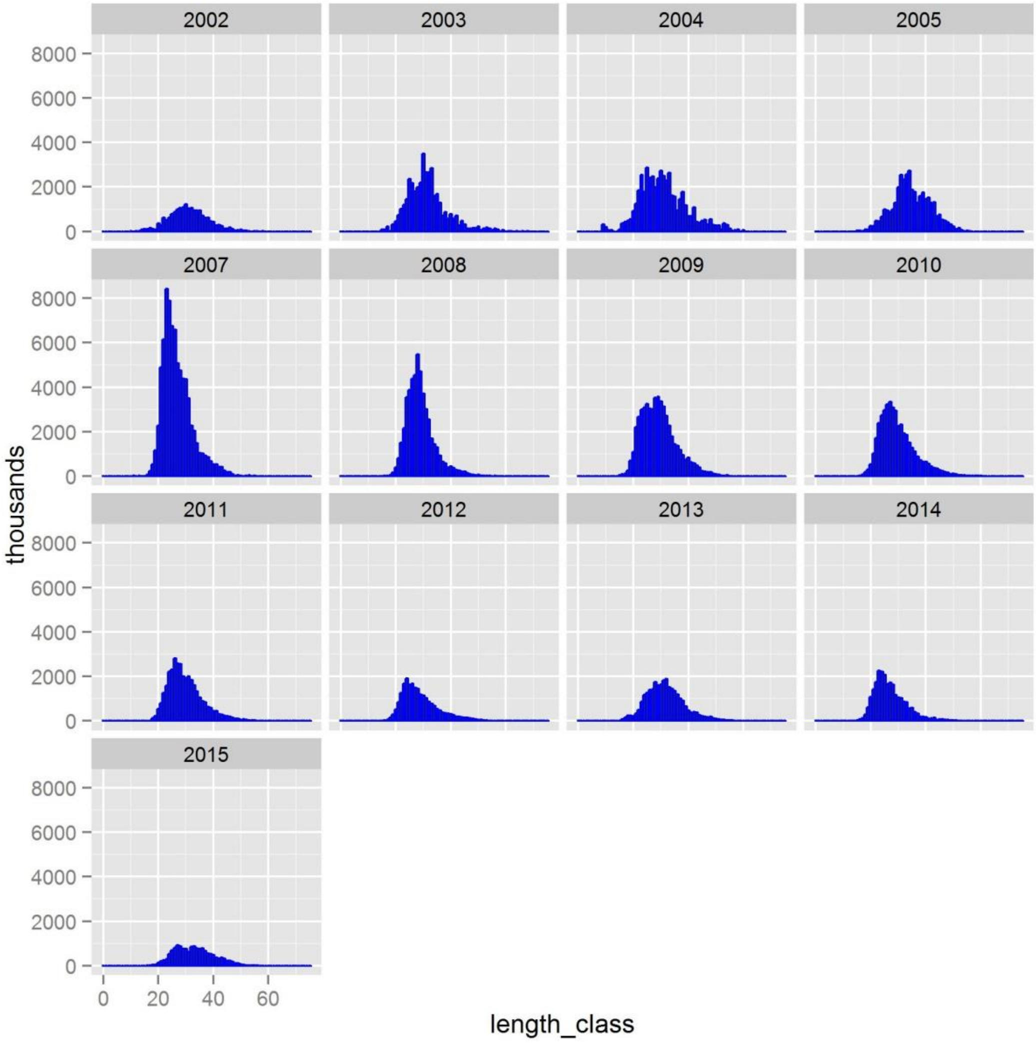


Figure 6.11.1.2.5. Norway lobster in GSA 18. Length frequency distribution of the Italian trawlers in the period 2002-2015.

Discards

The amount of discards reported by the trawlers is rather low. In GSA 17 the discards reported for the Croatian trawlers was between 7.5 and 17.85 t in the period 2013-2015. Data for Italian trawlers in GSA 17 are available only for 2011. In GSA 18 a quite high amount of discards (66.8 t) is reported for 2009 (Table 6.11.1.2.2).

Table 6.11.1.2.2 Norway lobster in GSAs 17 and 18. Reported annual discards of Croatian and Italian trawl fleets in GSAs 17 and 18.

	2009	2010	2011	2013	2014	2015
HRV GSA 17 OTB				13.74	7.48	17.85
ITA GSA 17 OTB			5			
ITA GSA 18 OTB	66.8	6.2	0.82	4	2.27	2.05

The size distributions of discards of Croatian trawlers and Italian trawlers in GSAs 17 and 18 are showed in Figure 6.11.1.2.6.

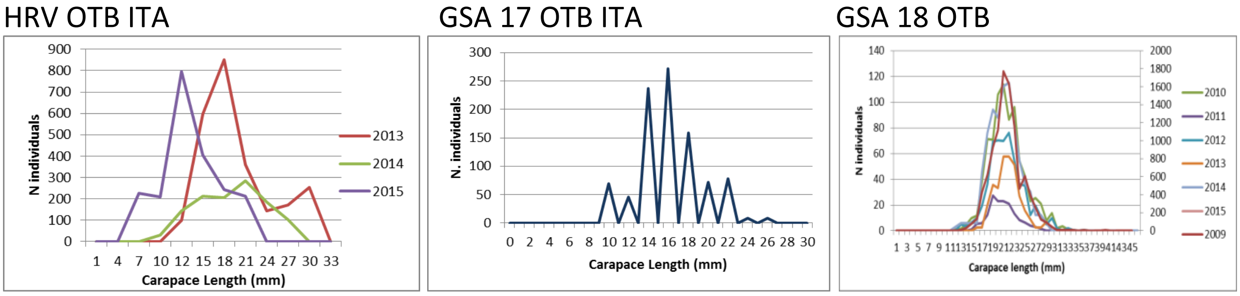


Figure 6.11.1.2.6 Norway lobster in GSAs 17 and 18. Size distributions of discards of Croatian trawlers and Italian trawlers in GSAs 17 and 18

6.11.1.3 Fishing effort data

Norway lobster in GSAs 17 and GSA 18 is exploited mostly by bottom trawlers. A small amount of catch is produced by small-scale vessels using traps in the northern-eastern Adriatic channels as well as by gillnetters in GSA 18. For this fleet Norway lobster is a minor by-catch of boats targeting hake on the continental slope. Effort data for the Italian trawl fleet (OTB) in GSA 17 and 18 is available since 2002, whereas nominal effort data of Croatian trawlers cover the period 2012-2015 (Table 6.11.1.3.1, Figure 6.11.1.3.1). The temporal trend shows a relevant reduction in the nominal effort (KW*fishing days) of the Italian trawl fleet both in GSA 17 (-50%) and GSA 18 (-60%). The Croatian fleet effort was stable in the last three years.

Table 6.11.1.3.1. Norway lobster in GSAs 17 and 18. Nominal effort in kW days for Italian (ITA), Croatian (HRV) OTB fleets, Croatian traps (FPO) and Italian gillnetters (GNS) in GSA 18.

	OTB			FPO	GNS
YEAR	HRV GSA17	ITA GSA 17	ITA GSA 18	HRV GSA17	ITA GSA 18
2002		27568094.43	17112021.58		1722336
2003		27486392.6	14530792.97		1002933
2004		27823853	14451460		1457047
2005		24094431	13550061		2035861
2006		19896811	14744610		1785782
2007		19409042	12840209		1280477
2008		20038778	11463435		894323
2009		18889991	13878367		1205076
2010		18094570	11856268		570405
2011		16572093	11329443		450946
2012	6878185	14020762	9821959	540079	395458
2013	7151551	12614324	10511626	654040	777758
2014	7291600	14435027	7736320	678016	207752
2015	7112694	13847944	7013616	707502	1129811

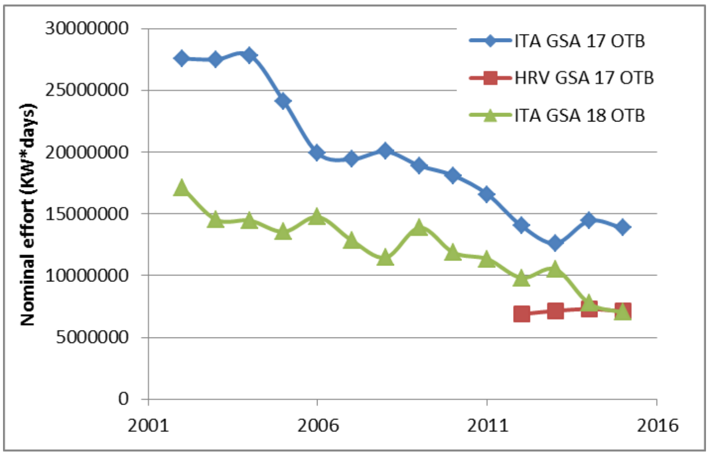


Figure 6.11.1.3.1. Norway lobster in GSAs 17 and 18. Trend in nominal effort of trawlers in GSA 17 and GSA 18

CPUE of Norway lobster of trawlers in GSAs 17-18 were calculated as total annual landings / total annual nominal effort*1000 (Figure 6.11.1.3.2). Trend in GSA 17 for the period 2006-2015 indicate an almost constant reduction of average CPUE since 2006 (-46%). In GSA 18, CPUE increased in the period 2002 to 2007, start declining since then (-35%). CPUE of Croatian trawlers in 2014-2015 were slightly higher than CPUE of Italian trawlers in GSA 17.

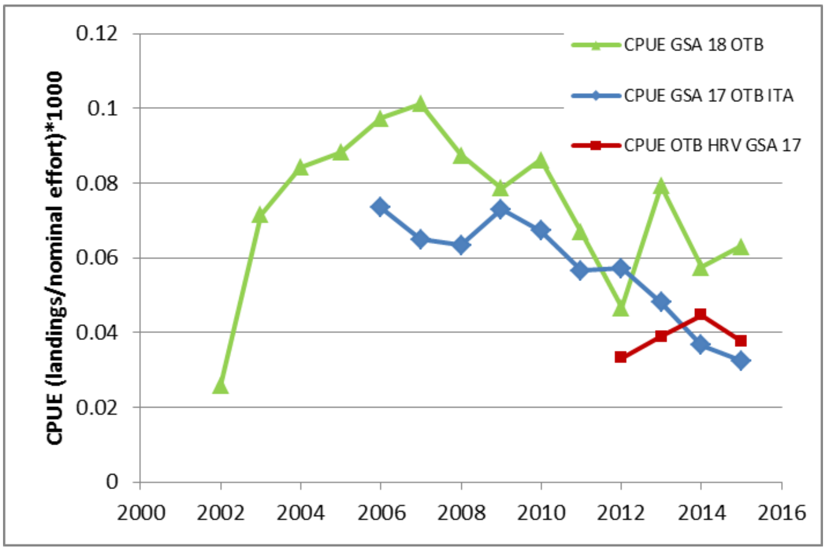


Figure 6.11.1.3.2. Norway lobster in GSAs 17 and 18. CPUEs of the Italian trawlers in GSA 17 and 18 and Croatian trawlers in GSA 17

6.11.1.4 Survey Indices of abundance and biomass by year and size/age

Methods

According to the MEDITS protocol (Bertrand et al., 2002), trawl surveys were carried out yearly (May - July), applying a random stratified sampling by depth (5 strata with depth limits at: 50, 100, 200, 500 and 800 m; each haul position randomly selected in small sub-areas and maintained fixed throughout the time (Figure 6.11.1.4.1). Haul allocation was proportional to the stratum area. The same gear (GOC 73, by P.Y. Dremière, IFREMER-Sète), with a 20 mm stretched mesh size in the cod-end, was used throughout the time series. Detailed data on the gear characteristics, operational parameters and performance are reported in Dremière and Fiorentini (1996). Considering the small mesh size a complete retention was assumed. All the abundance data (number of fish and weight per surface unit) were standardized to square kilometre, using the swept area method. Abundance and biomass indices were recalculated, based on the DCF data call.

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes haul duration. Only hauls noted as valid were used, including stations with no catches (zero catches are included).

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Yst = \Sigma (Yi*Ai) / A$$

$$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$$

Where:
A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance

V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± t(student distribution) * V(Yst) / n

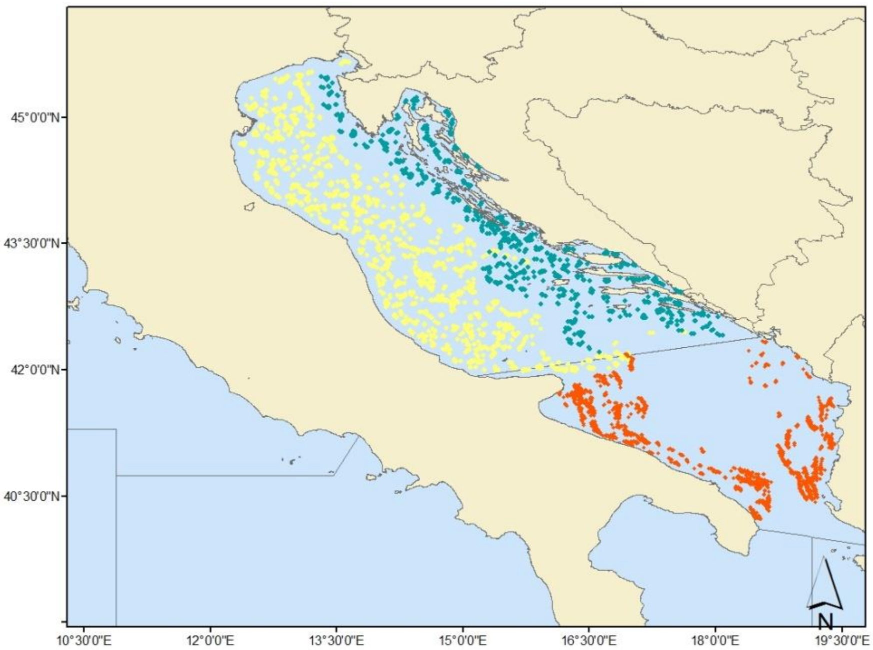


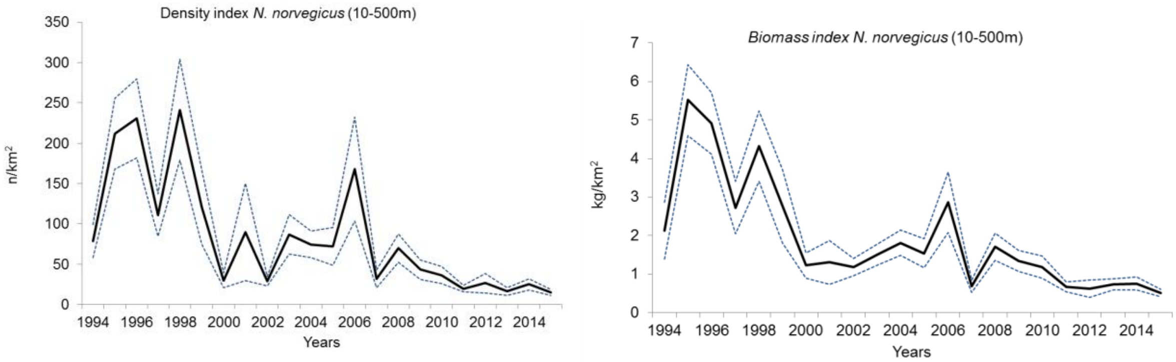
Figure 6.11.1.4.1. Norway lobster in GSAs 17 and 18. MEDITS trawl survey, distribution of the hauls carried out in the area.

Trends in abundance and biomass

Abundance and biomass indices of MEDITS display a decreasing temporal trend in GSA 17 with abundance decreasing of about 10 times since ‘90s in the Italian side. The pattern is slightly different in Croatian waters the early decline is also seen but where the indices show a modest increase since 2012 (Figure 6.11.1.4.2).

MEDITS indices of GSA 18 appear to be more stable with a peak in 2009 and a decreasing since then (Figure 6.11.1.4.3).

Italy GSA 17



Croatia GSA 17

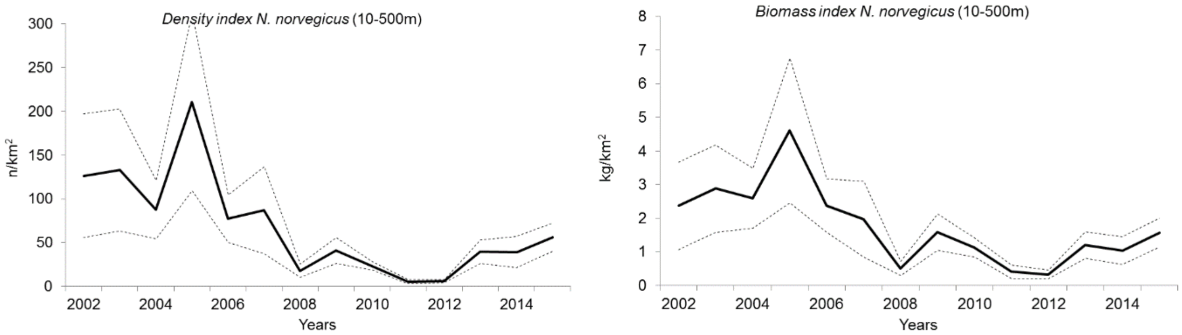


Figure 6.11.1.4.2. Norway lobster in GSA 17. Abundance (left) and biomass (right) indices from the MEDITS survey in the Italian and Croatian sides of GSA 17 during 1994 – 2015.

GSA 18

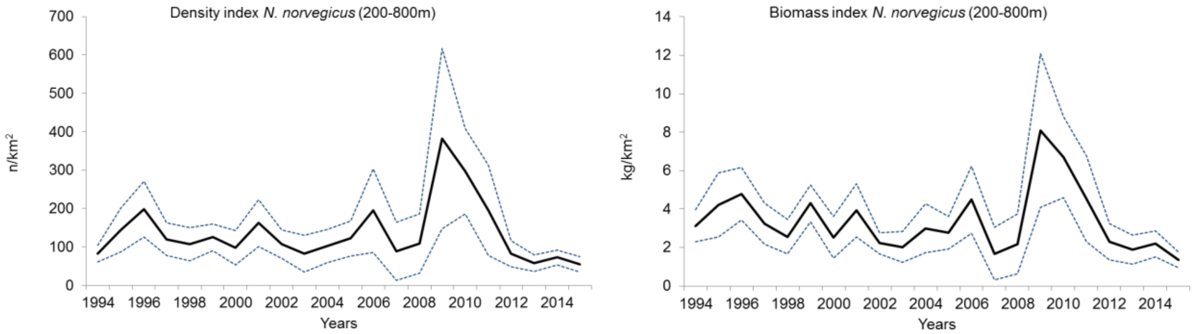


Figure 6.11.1.4.3. Norway lobster in GSA 18. Abundance (left) and biomass (right) indices from the MEDITS survey in GSA 18 in the period 1994 – 2015.

The temporal trend in frequency of occurrence (n. positive hauls/total n. hauls) of Norway lobster in MEDITS surveys carried out in the Italian side of GSA 17 and in the GSA 18 is showed in Figure 6.11.1.4.4. The trend is very similar in the two areas with a reduction of about 40% since mid-90s.

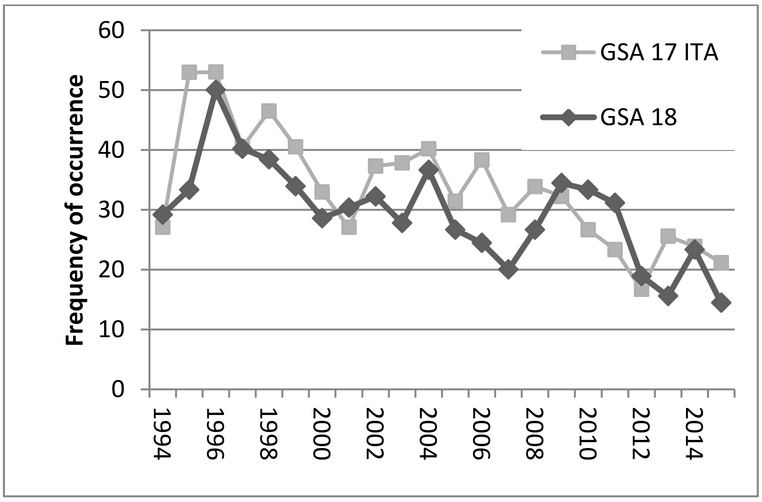
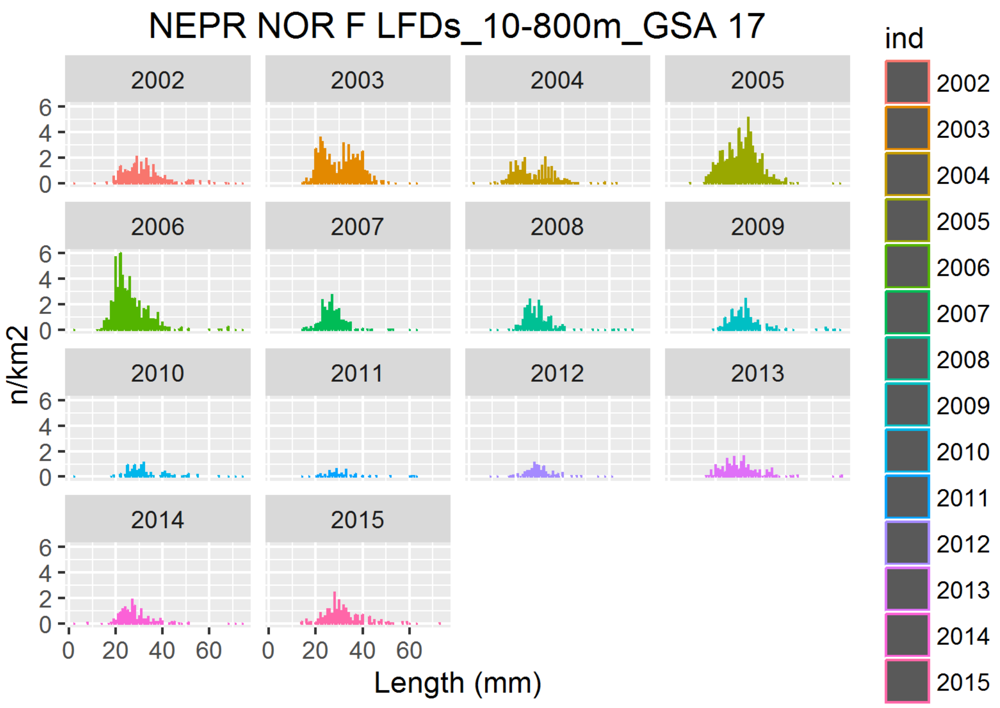


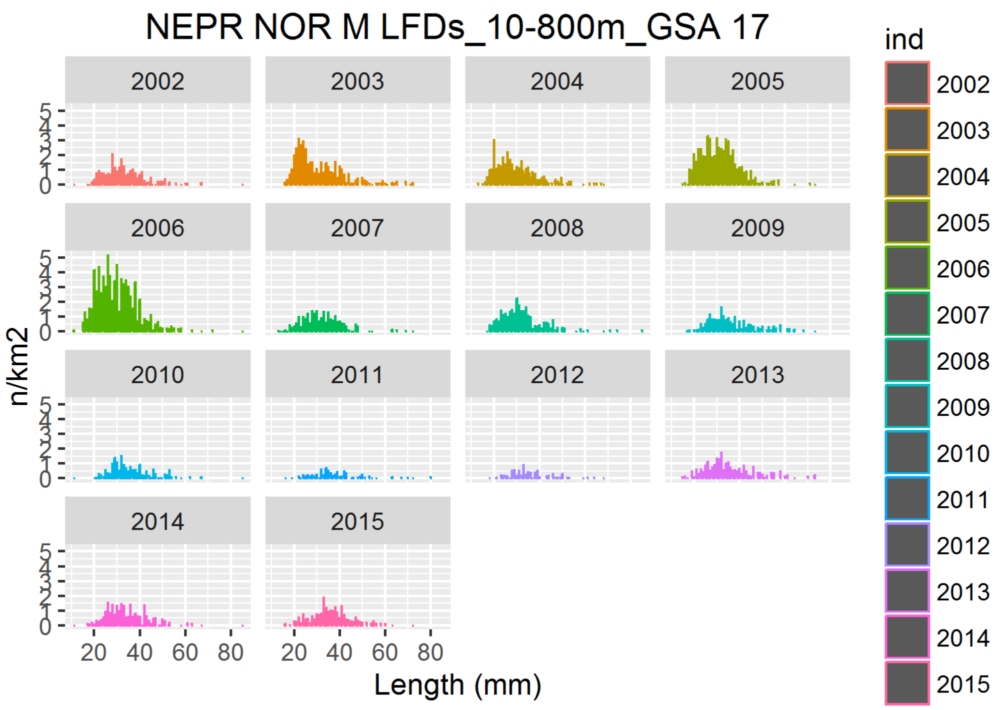
Figure 6.11.1.4.4. Norway lobster in GSAs 17 and 18. Frequency of occurrence (n of positive hauls/total n. hauls) during the MEDITS.

Length frequency distributions of the MEDITS surveys for females, males and sex combined are showed in Figures 6.11.1.4.5 and 6.11.1.4.6. In GSA 17 a recruitment peak appears in 2006 as observed in the catch data.

MEDITS GSA 17 *N. lobster* females



MEDITS GSA 17 *N. lobster* males



MEDITS GSA 17 *N. lobster* sex combined

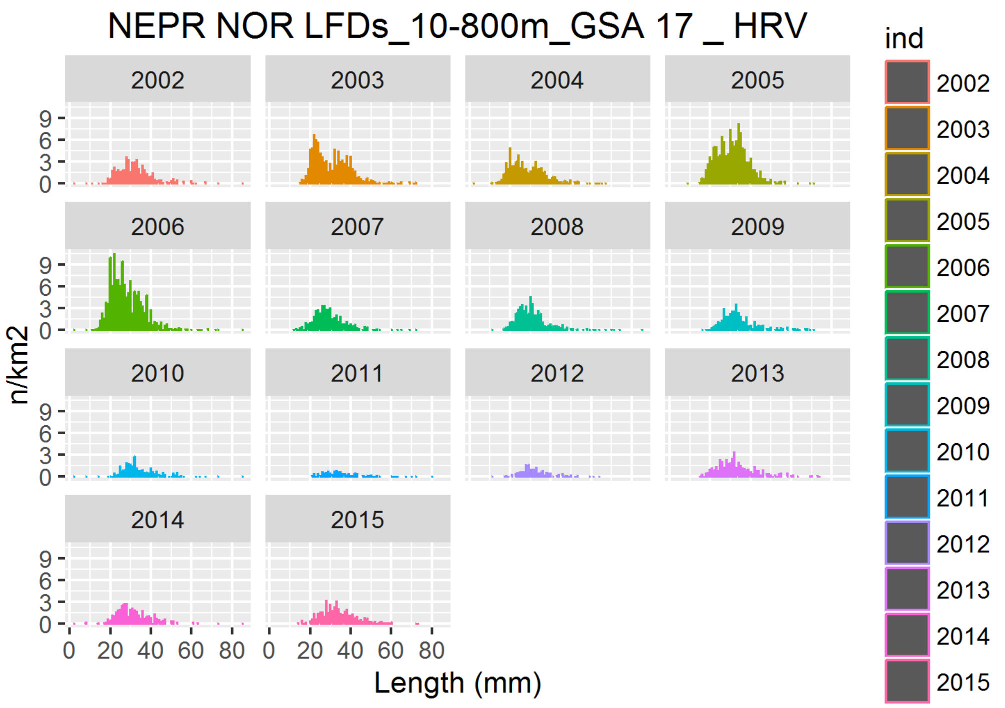
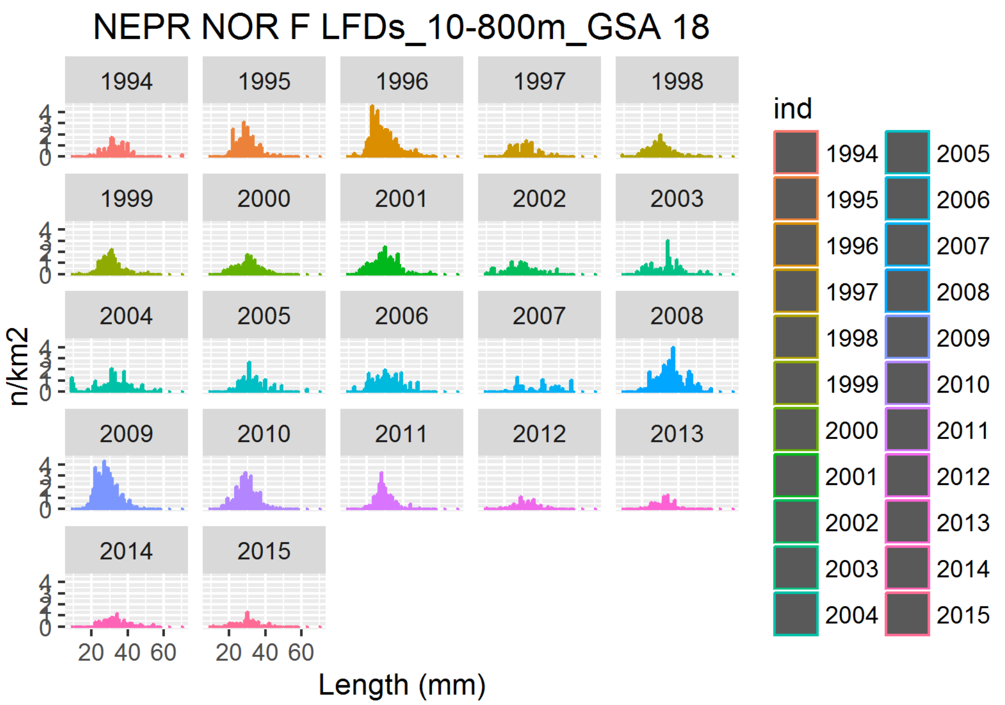
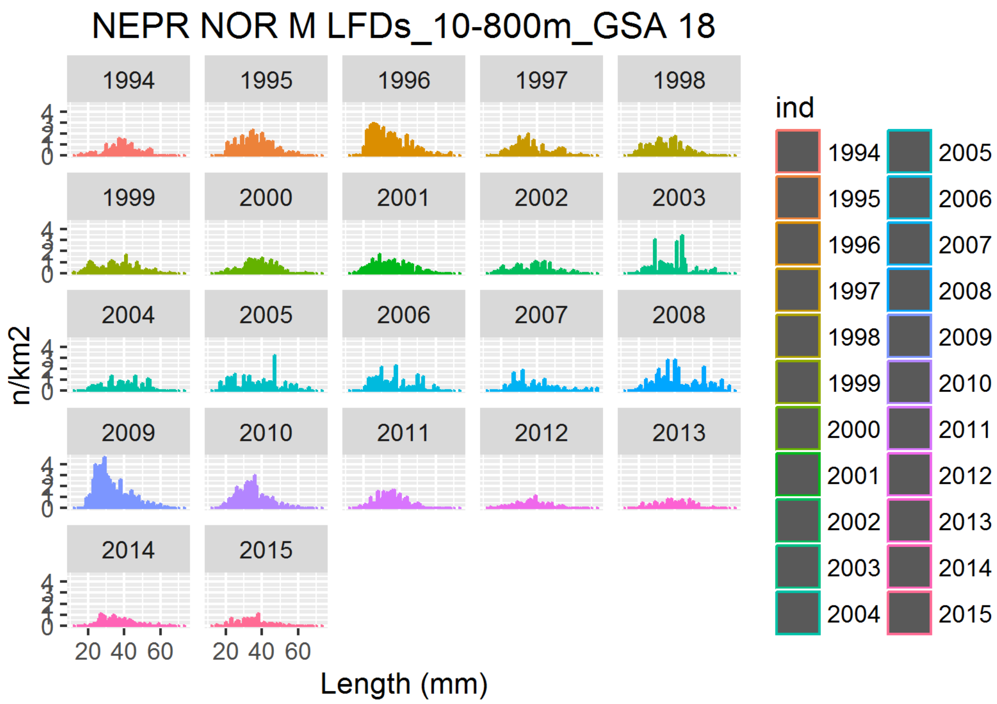


Figure 6.11.1.4.5. Norway lobster in GSA 17. Length frequency distributions of N. lobster females, males and sex combined of MEDITS survey in 2002-2015.

MEDITS GSA 18 *N. lobster* females



MEDITS GSA 18 *N. lobster* males



MEDITS GSA 18 ***N. lobster*** **sex combined**

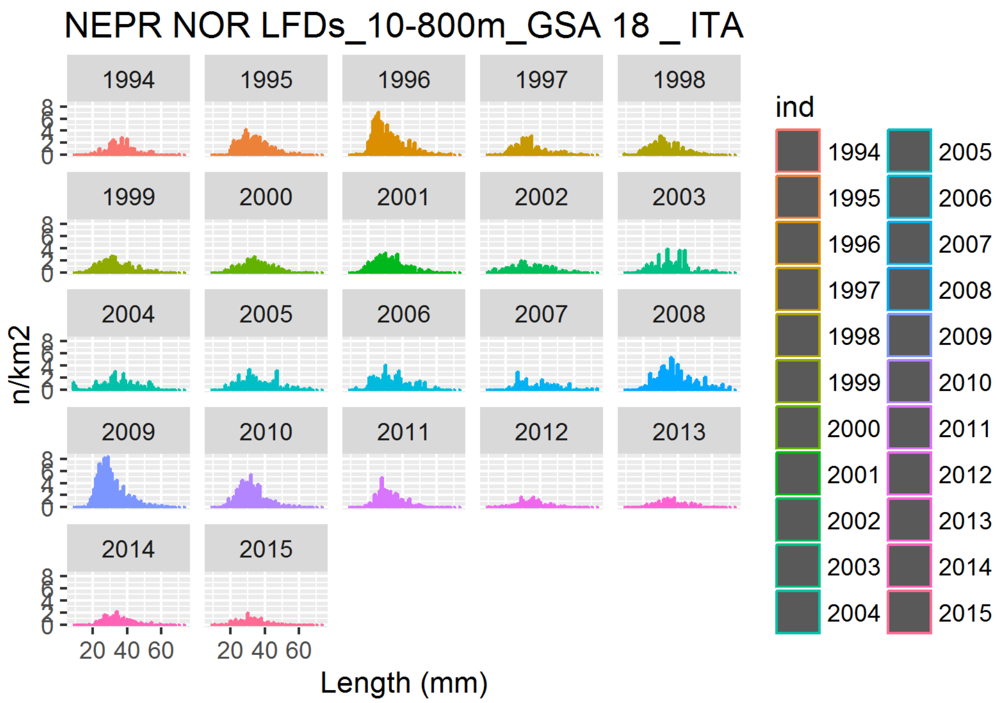


Figure 6.11.1.4.6. Norway lobster in GSA 18. Length frequency distributions of N. lobster females, males and sex combined of MEDITS survey in 2002-2015.

Abundance and size structures of N. lobster inside and outside Pomo Pit

MEDITS data show that N. lobster stock is distributed more or less homogenously in all the GSA (Figure 6.11.1.4.7).

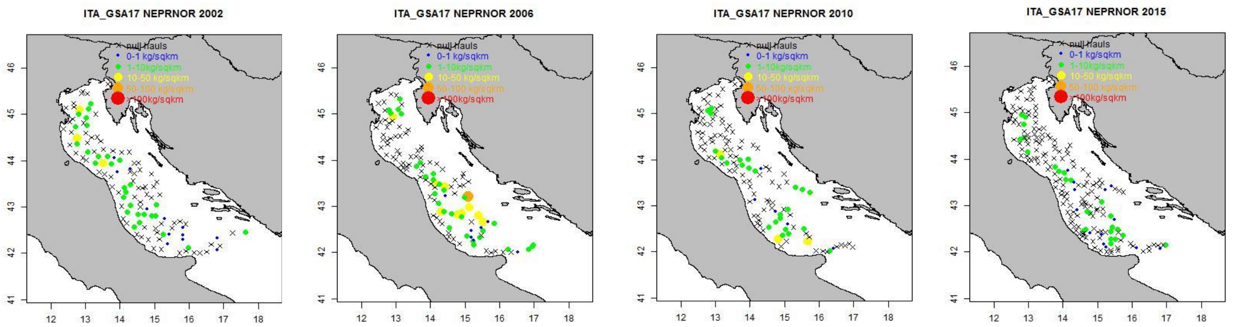


Figure 6.11.1.4.7. Norway lobster in GSA 17. Observed density values during Medits 2002, 2006, 2010 and 2015.

A visual inspection of the distribution of density values observed during MEDITS 2006, when a high year class has occurred, indicate that the Pomo Pit area play an important role for recruitment. Map in Figure 6.11.1.4.8 shows that the Pomo Pit area is connected with the Adriatic Basin in GSA 18 by a narrow channel between 100 and 150 m depth.

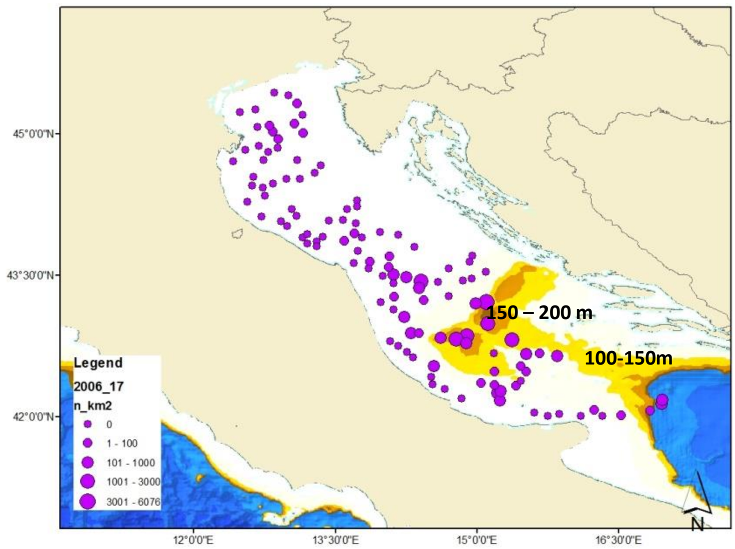


Figure 6.11.1.4.2.8. Norway lobster in GSA 17. Observed density values during MEDITS 2006.

Figure 6.11.1.4.2.9. clearly show a different size distribution between the N. lobster specimens distributed inside and outside the Pomo Pit with this latter displaying generally a peak of small specimens and the lack of adults over 50 mm CL.

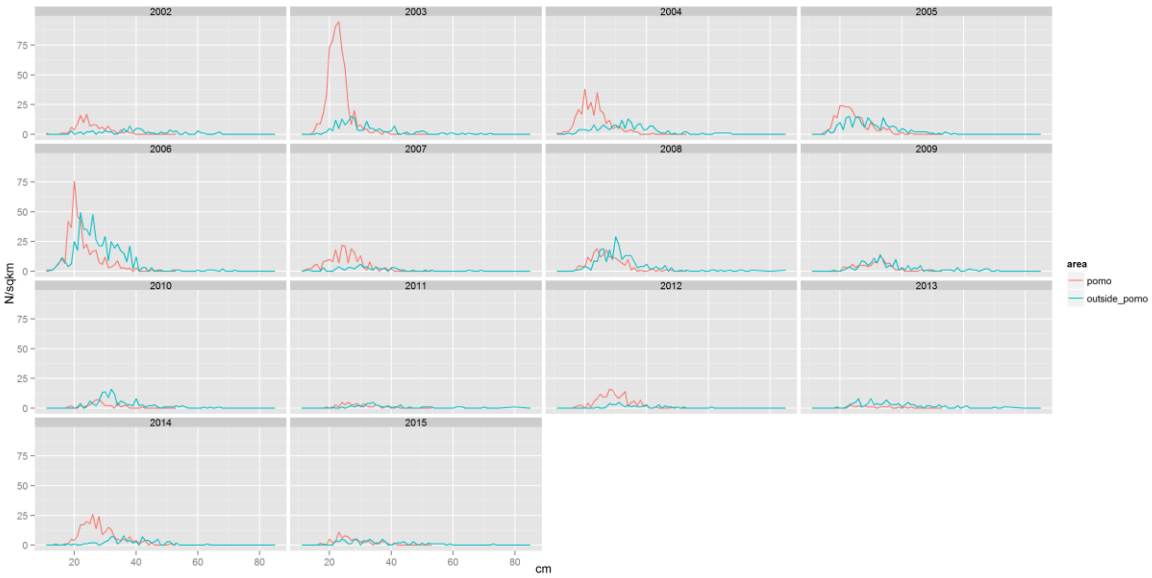


Figure 6.11.1.4.2.9. Norway lobster in GSA 17. MEDITS length frequency distributions (n km^{-2}) of specimens distributed inside and outside the Pomo Pit area.

6.11.2 STOCK ASSESSMENT ON NORWAY LOBSTER IN GSAs 17 AND 18

Method 1- Surplus Production model in Continuous Time - SPiCT

The Surplus Production in Continuous time (SPiCT) assessment method is briefly described here; Pedersen and Berg (2016) contains a comprehensive description of the model

The SPiCT assessment method is a state-space version of the Pella-Tomlinson surplus production model (Pella and Tomlinson 1969). The dynamics of fisheries (F_t) and exploitable biomass (B_t) are modelled as latent processes:

$$dB_t = rB_t\left(1 - \left(\frac{B_t}{K}\right)^{n-1}\right)dt - F_tB_tdt + \sigma_B B_t dW_t$$

$$\mathrm{dlog}(F_t) = f(t, \sigma_F)$$

Where W_t is Brownian motion and f represents a random walk process if yearly data are provided and a seasonal model for F if subannual data are available. The time series of catch and biomass index are used as observations with e_t and ϵ_t their corresponding error terms:

$$\log(I_t) = \log(qB_t) + e_t, e_t \sim \mathcal{N}(0, [\alpha\sigma_B]^2)$$

$$\log(C_t) = \log\left(\int_t^{t+\Delta} F_s B_s ds\right) + \epsilon_t, \epsilon_t \sim \mathcal{N}(0, [\beta\sigma_F]^2)$$

The following list summarises the model parameters:

- B_t: Exploitable biomass
- F_t: Fishing mortality
- r: Intrinsic growth rate (growth, recruitment, natural mortality)
- K: Carrying capacity

- n: Production curve shape parameter
- q: Catchability
- σ_B: Standard deviation of B_t
- σ_F: Standard deviation of F_t
- α: Ratio of standard deviation of I_t to σ_B
- β: Ratio of standard deviation of C_t to σ_F

SPiCT allows the inclusion of prior distributions for parameters that are difficult to estimate. By default, there are wide uninformative priors on n, α, and β; these can be removed.

The continuous time formulation of the model allows for arbitrary and irregular data sampling without a need for catch and index observations to match temporally.

Main assumptions

SPiCT shares many assumptions with other surplus production models:

1. No emigration/immigration, changes in biomass occur through growth (r and K) and fishing.
2. No lagged effects in the biomass dynamics
3. Constant catchability i.e. no change in technology of fishing technique that changes q.
4. Gear selectivity is not modelled
5. No knowledge of natural mortality is required

Data requirements - Expected outputs

SPiCT requires a time series of landings or catches and one or more time series of commercial or survey CPUE indices. The expected output include all parameter estimates and the most interesting derived quantities are the F/F_{msy} and B/B_{msy} that quantify the stock status. The results are presented using SPiCT's extensive plotting capabilites.

Forecasting and management

SPiCT is able to use the estimated underlying process model to make forecast of biomass, fishing mortality, catch and stock status (F/F_{msy} and B/B_{msy}). A forecasting period and a fishing scenario is set before fitting the model. The fishing scenario is a multiplication factor that is applied to the current fishing mortality.

Availability

SPiCT is available as an R (R Core Team 2015) package in the github online repository: https://github.com/mawp/spict. For fast and efficient estimation, SPiCT uses the Template Model Builder package (TMB, Kristensen et al., 2016).

INPUT Data

Tuning

Available CPUE's to be used as a tuning index in SPICT runs were recovered from historical literature and from the MED and BS DG MARE Data Call of 2016.

“HVAR”

CPUE data for Norway lobster was available in the HVAR demersal survey performed in 1948-49, after 8 years of no fishing in the Adriatic Sea (Karlovac 1956, 1959). Abundance is reported to compare HVAR and MEDITS scaled by swept area and by tow duration. Swept area from MEDITS is reported while that of HVAR is reconstructed base on the work of G.C Osio (Unpublished) and assumes a constast wing opening of 0.27 * footrope (35 m). In Figure 6.11.2.1. the lower and upper "hinges" correspond to the first and third quartiles (the 25th and 75th percentiles), boxes are drawn with widths proportional to the square-roots of the number of observations in the groups, middle line corresponds to median. The comparison 1948-48 with the period 1994-2001 shows a marked decline in both CPUEs. This is more pronounced when the net dimensions are accounted for. Given the uncertainty in reconstructing HVAR gear dimensions and the distance of the HVAR CPUE from the beginning of landings time series (1970) this CPUE was not used in the stock assessment, but it nevertheless represent an important background information.

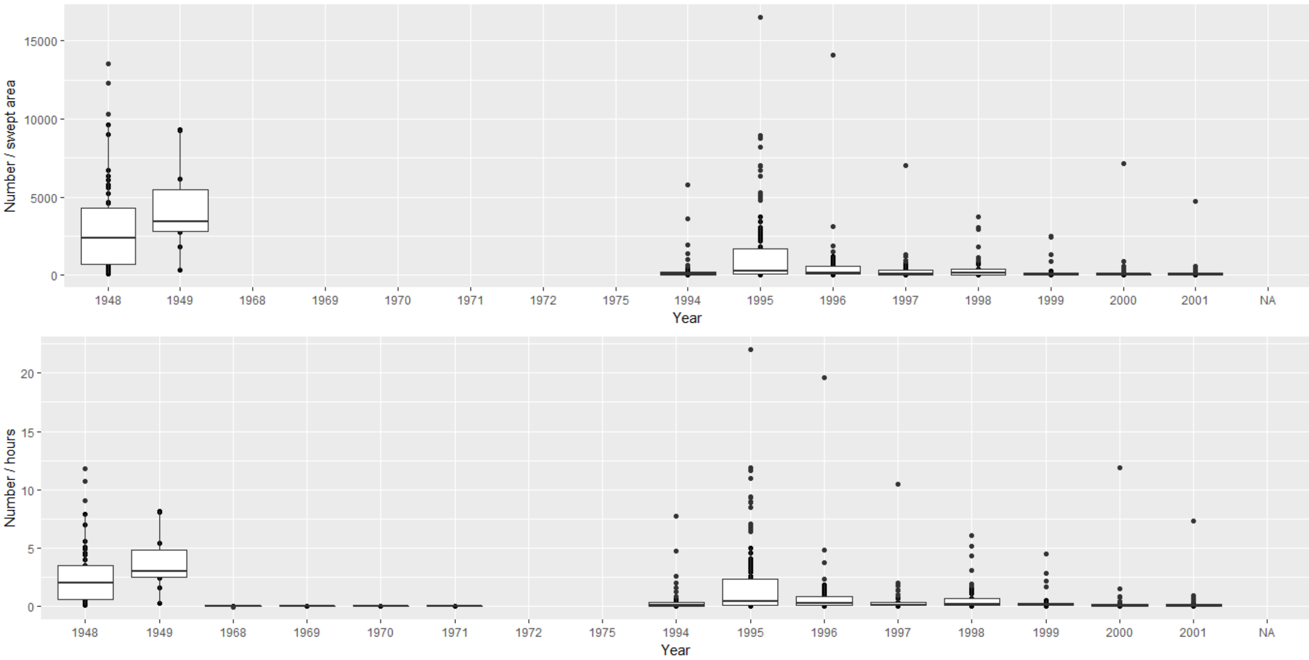


Figure 6.11.2.1. Norway lobster in GSAs 17 and 18. Norway lobster CPUE from the HVAR survey (1948-49) and from MEDITS (1994-2001). Boxplots with (upper panel) Norway lobster Abundance/swept area and (lower panel) Abundance/ tow duration.

Jukic data

S. Jukic reported the yearly performance of trawlers fishing in the commercial grounds off Blitvenica (East Pomo Pit, Central Adriatic, Figure 6.11.2.2.). The CPUE represents on average 8 trawlers over 555 fishing days in the period 1960-1970 (Figure 6.11.2.3).

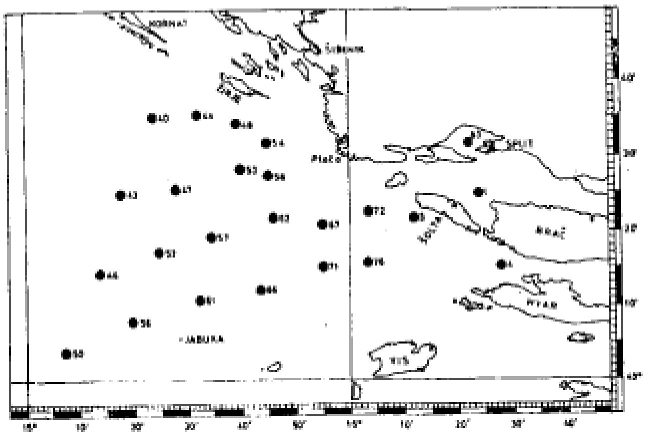


Figure 6.11.2.2. Norway lobster in GSAs 17 and 18. Area covered by the CPUE from Jukic 1975

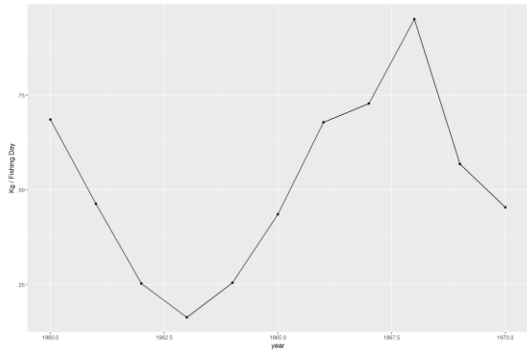


Figure 6.11.2.3 Norway lobster in GSAs 17 and 18. Norway lobster CPUE (kg/Fishing day) from Jukic (1975) in the East part of Pomo Pit (Blitvenica fishing grounds), Central Adriatic.

Froglia and Gramitto data

Froglia & Gramitto (1988) reported hourly CPUE's for Norway lobster in the fishing grounds offshore Ancona (Western Central Adriatic). CPUE's are reported for night/day/combined fishing and a yearly average was computed to build a tuning index (Figures 6.11.2.4 - 5).

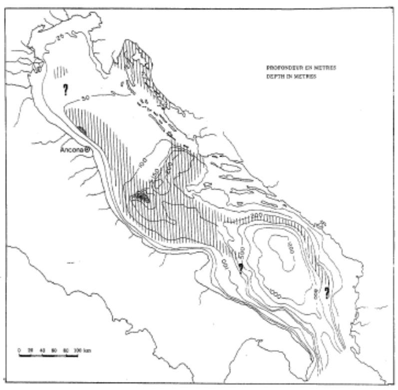


Figure 6.11.2.4 Norway lobster in GSAs 17 and 18. Area were CPUE data was taken by Froglia & Gramitto 1988

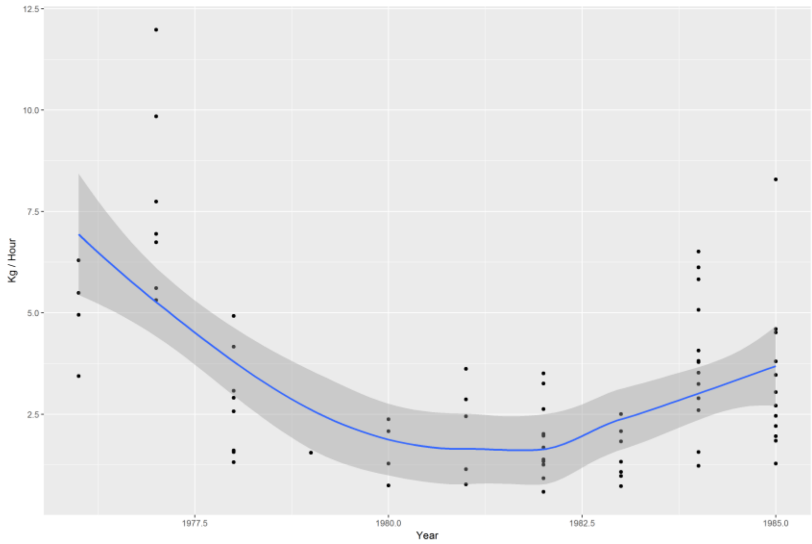


Figure 6.11.2.5 Norway lobster in GSAs 17 and 18. CPUE (kg/fishing hour) reconstructed from Froglia (1985) in Ancona fishing grounds, Central Adriatic.

MEDITS

MEDITS trawl survey data is available from all EU MED GSAs since 1994, however GSA 17 is the only exception and data is available only since 2002. Given clear indication of a declining trend in MEDITS index in GSA 17, an effort was made to recover the time series since 1994. A source for this data is the Mannini & Sabatella (2015) reporting the stratified kg/km^2 for Norway lobster on the Italian part of GSA 17 (Figure 6.11.2.6).

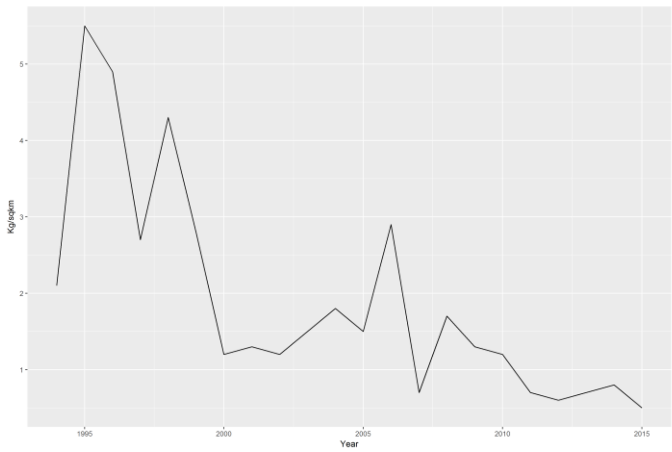


Figure 6.11.2.6 Norway lobster in GSAs 17 and 18. MEDITS GSA 17 Italian part only reported in the MEDITS ANNUAL reports. The trend 2002-2015 was replicable with available DCF raw data.

For GSA 18 two stratified indexes were computed, one only covering the Italian side of GSA 18 and one including the tows performed in front of Albania and Montenegro.

<u>Derivation of combined MEDITS index</u>

To build a representative MEDITS index covering the entire period 1994-2015 and the whole area of GSA 17-18, we derived a first index for the period 1995-2001. This was computed by weighting each individual index by the corresponding surveyed surface, details as follows:

$$\frac{(AI_{17} + AC_{17}) * IndI_{17} + A_{18} * Ind_{18}}{AI + AC + A_{18}}$$

Where AI_{17} is the surface (km^2) surveyed in the Italian strata of GSA 17, AC_{17} is the surface (sqkm) surveyed in the Croatian strata of GSA 17, A_{18} is the surface (sqkm) surveyd in the all the strata of GSA 18 (Italy, Albania and Montenegro), $IndI_{17}$ is the stratified mean index of biomass (kg/km^2) from the Italian side of GSA 17 and $Ind_{18}$is the stratified mean index of biomass (kg/km^2) from the whole GSA 18.

The second part of the combined index, thanks to the available raw data, was computed according to the stratified means for GSA 17-18 from 2002-2005 covering all hauls performed by Italy, Croatia, Albania and Montenegro (MEDITS_17_18) (Table 6.11.2.1, Figure 6.11.2..7).

Table 6.11.2.1 Norway lobster in GSAs 17 and 18. MEDITS indexes for Norway lobster in GSA 17 and 18

Year	MEDITS18_ITA	MEDITS18_ITA_ALB_MTG	MEDITS17_ITA	MEDITS_17_18
1994	1.14	1.34	2.10	**1.92**
1995	1.64	1.93	5.50	**4.64**
1996	3.03	2.88	4.90	**4.41**
1997	1.66	1.40	2.70	**2.38**
1998	1.35	1.40	4.30	**3.60**
1999	1.46	1.43	2.80	**2.47**
2000	1.05	1.43	1.20	**1.25**
2001	1.23	1.79	1.30	**1.41**
2002	0.76	0.98	1.20	2.02
2003	0.61	1.31	1.50	2.73
2004	1.11	1.65	1.80	3.16
2005	0.79	1.74	1.50	3.44
2006	1.25	1.59	2.90	3.50
2007	0.43	1.04	0.70	1.63
2008	0.77	3.16	1.70	3.68
2009	2.49	3.06	1.30	3.28
2010	2.14	1.90	1.20	2.02
2011	1.31	1.27	0.70	1.00
2012	0.63	0.81	0.60	0.90
2013	0.55	0.79	0.70	2.08
2014	0.67	0.85	0.80	1.98
2015	0.51	0.50	0.50	1.64

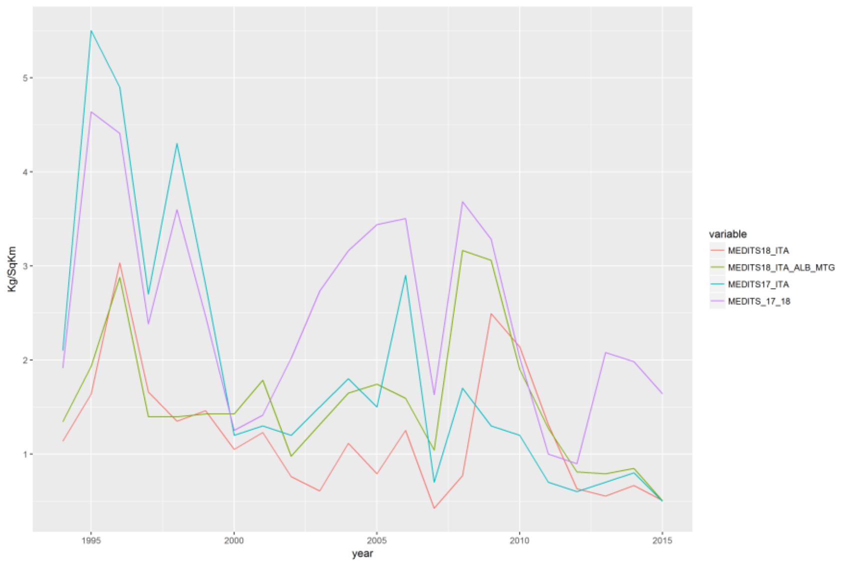


Figure 6.11.2.7 Norway lobster in GSAs 17 and 18. MEDITS trends for Norway lobster in GSA 17 and 18. MEDITS_18_ITA covers only the Italian side of GSA 18, MEDITS18_ITA_ALB_MTG covers the entire GSA 18 including the East part, MEDITS 17_ITA represents only Italian side of GSA 17, MEDITS 18_17 is the reconstructed index covering whole GSA 17 & 18.

Landings

Stock assessment models and in particular surplus production models need long and informative time series of catch for unbiased parameter estimation. In the Mediterranean these are often not available, so to provide a sufficiently long time series for the stock assessment of Norway lobster in GSA 17-18 an effort was made to recover the historical landings for the area. Three sources of landings were used to reconstruct catch time series for the whole GSA 17-18:

- Italian landings time series from National Institute for Statistics (ISTAT) for the period 1961-2000 for GSA 17 and 18 (Figures 6.11.2. 8 and 6.11.2.9).
- GFCM landings for the period 1970-2014 for Croatia, Montenegro and Albania extracted from FAO FISAT J.
- DCF landings from the 2015 DG MARE Data Call, covering the period 2002-2015 for GSA 17 and 18 (ITA) and GSA 17 (HRV).

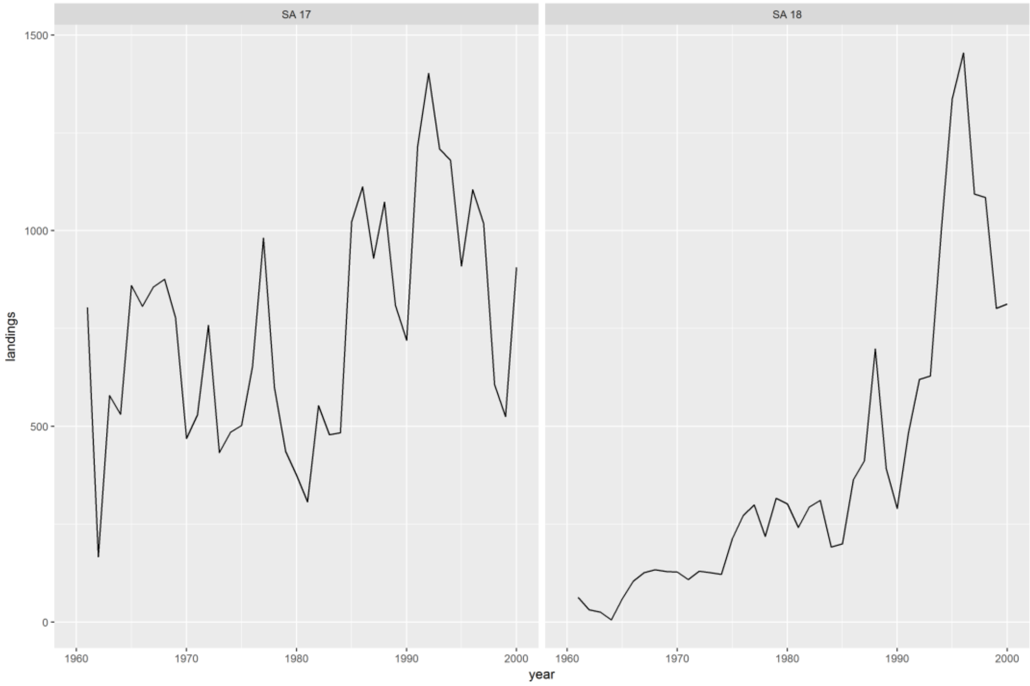


Figure 6.11.2.8 Norway lobster in GSAs 17 and 18. Landings (tons) from ISTAT for Norway lobster in Italian waters of GSA 17 and 18.

The reconstruction of catches was straight forward in GSA 17 with the GFCM series that cover the whole area (FAO 37.2.1), were the trends and level of landings is consistent with the Italian ISTAT for 1970-2000. In GSA 18 GFCM data for FAO area 37.2.2 includes also GSA 16 and parts of Greece so it was not possible to use these time series as the Norway lobster landings in GSA 16 are large. For cross checking the ISTAT landings from GSA 16 were subtracted from the GFCM 37.2.2 landings and compared with the ISTAT trends in GSA 18 (1970-2000). These were consistent, so the use of ISTAT GSA 18 was considered representative of Italian removals in GSA 18.

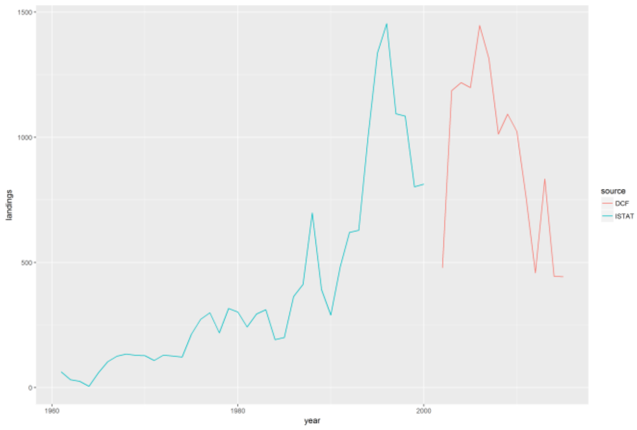


Figure 6.11.2.9 Norway lobster in GSAs 17 and 18. Landings (tons) from ISTAT and DCF for Norway lobster in Italian waters of GSA 18.

Finally, for the combined assessment the following time series were used, in GSA 17 GFCM 1970-2014 (ITA & HRV) and DCF 2015 (ITA & HRV), in GSA 18 ISTAT 1970-2000 (ITA), DCF 2002-2015 (ITA), GFCM 1970-2014 for Albania and Montenegro. The missing catch in GSA 18 (ITA) for year

2001 was replaced with the mean of 2000 and 2002. Final reconstructed landings are presented in Figure 6.11.2.10 and Table 6.11.2.2

Figure 6.11.2.10. Norway lobster in GSAs 17 and 18. Reconstructed Landings (tons) for Norway lobster in GSA 17 and 18 including Albania.

Table 6.11.2.2 Norway lobster in GSAs 17 and 18. Reconstructed Landings (tons) for Norway lobster in GSA 17 and 18 including Albania.

year	gsa17 (ITA+HRV)	gsa18 (ITA)	Albania
1970	1142	127.995	0
1971	1175	108.481	0
1972	1267	130	0
1973	987	126	0
1974	976	122	0
1975	984	213	0
1976	1247	273	0
1977	1805	299	0
1978	1250	219	0
1979	972	316	0
1980	814	302	0
1981	943	242	0
1982	1113	294	0
1983	959	311	0
1984	1027	192	0
1985	1909	200	0
1986	1986	364	0
1987	1675	412	0
1988	2138	698	0
1989	1767	392	0
1990	1600	290	0
1991	2024	483	0
1992	2531	620	0
1993	2493	629	0

1994	2366	1000	0
1995	1811	1337	0
1996	2104	1454	3
1997	1964	1094	0
1998	1341	1085	0
1999	951	802	0
2000	1051	813	0
2001	913	645.7367	10
2002	774	478.4735	5
2003	1032	1186.55	2
2004	1061	1218.43	2
2005	2195	1198.676	0
2006	1966.1	1446.647	4
2007	1728.2	1314.634	0
2008	1530.9	1012.8	1
2009	1810.5	1092.894	0
2010	1594.6	1023.423	0
2011	1223.3	759.1686	0
2012	1062.6	458.7038	0
2013	912.1	833.8332	0
2014	886.7	444.7175	0
2015	718.9296	442.7535	0

Stock Assessment

The choice of stock assessment method to use for this stock was based on careful consideration of a number of issues. The different sources of sources of data and their short comings discussed above were considered together. The type of model was selected based on the following arguments: Ageing of Decapoda like *Nephrops norvegicus* is difficult and relies on indirect methods. With the specific uncertainties for this stock identified and explained in sections above on growth; the uncertainties on the proportion of the stock that lives in and outside Pomo, the potential mixing of landings between Nephrops from GSA 17 and 18 (STECF EWG 16-08), the EWG deemed that the only viable approach assessment to provide scientific advice is to use a production model on the combined GSA 17-18 as requested by the TORs. As STECF (PLEN 03) recommended the use of SPiCT, this was the model of choice for the surplus production assessment.

Input data described in data section are reported below in the following R list. This forms the input data basis for the 3 runs on Nephrops GSA 17-18 combined:

nep1718d

```
$obsC (COMBINED LANDINGS GSA 17 + 18)
 [1] 1269.995 1283.481 1397.000 1113.000 1098.000 1197.000 1520.000 2104.000 1469.000 1288.000
[11] 1116.000 1185.000 1407.000 1270.000 1219.000 2109.000 2350.000 2087.000 2836.000 2159.000
[21] 1890.000 2507.000 3151.000 3122.000 3366.000 3148.000 3558.000 3058.000 2426.000 1753.000
[31] 1864.000 1558.737 1252.473 2218.550 2279.430 3393.676 3412.747 3042.834 2543.700 2903.394
[41] 2618.023 1982.469 1521.304 1745.933 1331.417 1161.683
```

```
$timeC (COMBINED LANDINGS GSA 17 + 18)
 [1] 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987
[19] 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005
[37] 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015

$timeI
$timeI[[1]] (from Jukic 1975)
 [1] 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985

$timeI[[2]] (from Froglia 1988)
 [1] 1960 1961 1962 1963 1964 1965 1966 1967 1968 1969 1970 1972

$timeI[[3]] (MEDITS GSA 17 ITA + GSA 18 all)
[1] 1996 1997 1998 1999 2000 2001

$timeI[[4]] (MEDITS GSA 17 - 18 ITA+HRV+ALB+MTG)
[1] 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015


$obsI
$obsI[[1]] (from Jukic 1975)
 [1] 5.044500 7.740429 2.766750 1.551000 1.621000 2.169400 1.867563 1.449312 3.866662 3.348465

$obsI[[2]] (from Froglia 1988)
 [1] 68.64132 46.32997 25.28125 16.38208 25.47517 43.61067 67.90581 72.84041 95.12000 56.87619
[11] 45.43182  0.00000

$obsI[[3]] (MEDITS GSA 17 ITA + GSA 18 all)

[1] 4.408880 2.383859 3.599060 2.467033 1.252567 1.414234

$obsI[[4]] (MEDITS GSA 17 - 18 ITA+HRV+ALB+MTG)
 [1] 2.0177569 2.7319675 3.1626022 3.4391495 3.5022395 1.6299287 3.6815984 3.2841491 2.0248443
[10] 1.0000061 0.8984729 2.0794126 1.9832374 1.6419650
```

To explore the sensitivity of the results to the data different model runs were set up to explore different combinations of areas, time span and time series of landings and CPUEs.

Initial runs were performed on GSA 17 only with FAO Landings 1970-2015, all tuning CPUE's since 1960, MEDITS Italian side only for 1995-2015, models had good convergence and residuals (not shown). Similarly runs were performed on GSA 18 only with Landings 1970-2015, MEDITS GSA 18 Italian side only for 1995-2015 or MEDITS GSA 18 whole area for 1995-2015 (not shown).

Once these exploratory runs were made, in order to directly address the TOR of an assessment of GSA 17-18 combined, the data were combined by sum for the landings and a mean index for MEDITS as described above. The three runs carried out are:-

1. GSA 17-18, Landings 1970-2015, all tuning CPUE's since 1960 (Juckic and Froglia 1988), MEDITS a 1995-2001 and MEDITS b 2002-2015 (run #1).
2. GSA 17-18, Landings 1990-2015, MEDITS a 1995-2001 and MEDITS b 2002-2015 (**run #2)**.
3. GSA 17-18, Landings 1990-2015, MEDITS b 2002-2015 (**run #3)**.

Model run #1

Input data GSA 17-18, Landings 1970-2015, all tuning CPUE's since 1960 (Juckic and Froglia), MEDITS a 1996-2001 and MEDITS b 2002-2015. MEDITS was explicitly split in two distinct tuning indexes to account for the difference of the 1996-2001 index being derived only on the Italian side in GSA 17 from an index covering the whole GSA 18-18 starting in 2002 (Figure 6.11.2.11).

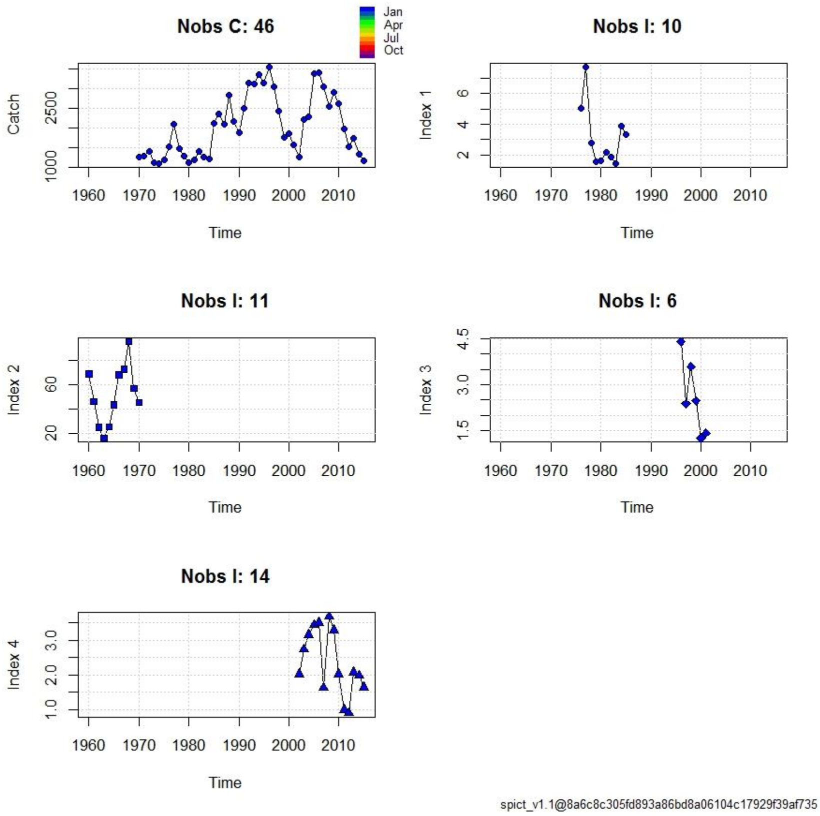


Figure 6.11.2.11 Norway lobster in GSAs 17 and 18. Input Data from Norway lobster GSA 17-18 Model run #1. Index 1 = Froglia, Index 2 = Jukic, Index 3 = MEDITS 1995-2001, Index 4 = MEDITS 2002-2005.

SPiCT was run with the default prior settings and no informative priors for initial parameter estimates. The model converged and the diagnostic results (Residuals, Auto correlation and Shapiro p-values) are good for both catches and the 4 tuning indexes (Figures 6.11.2.12 and 6.11.2.13).

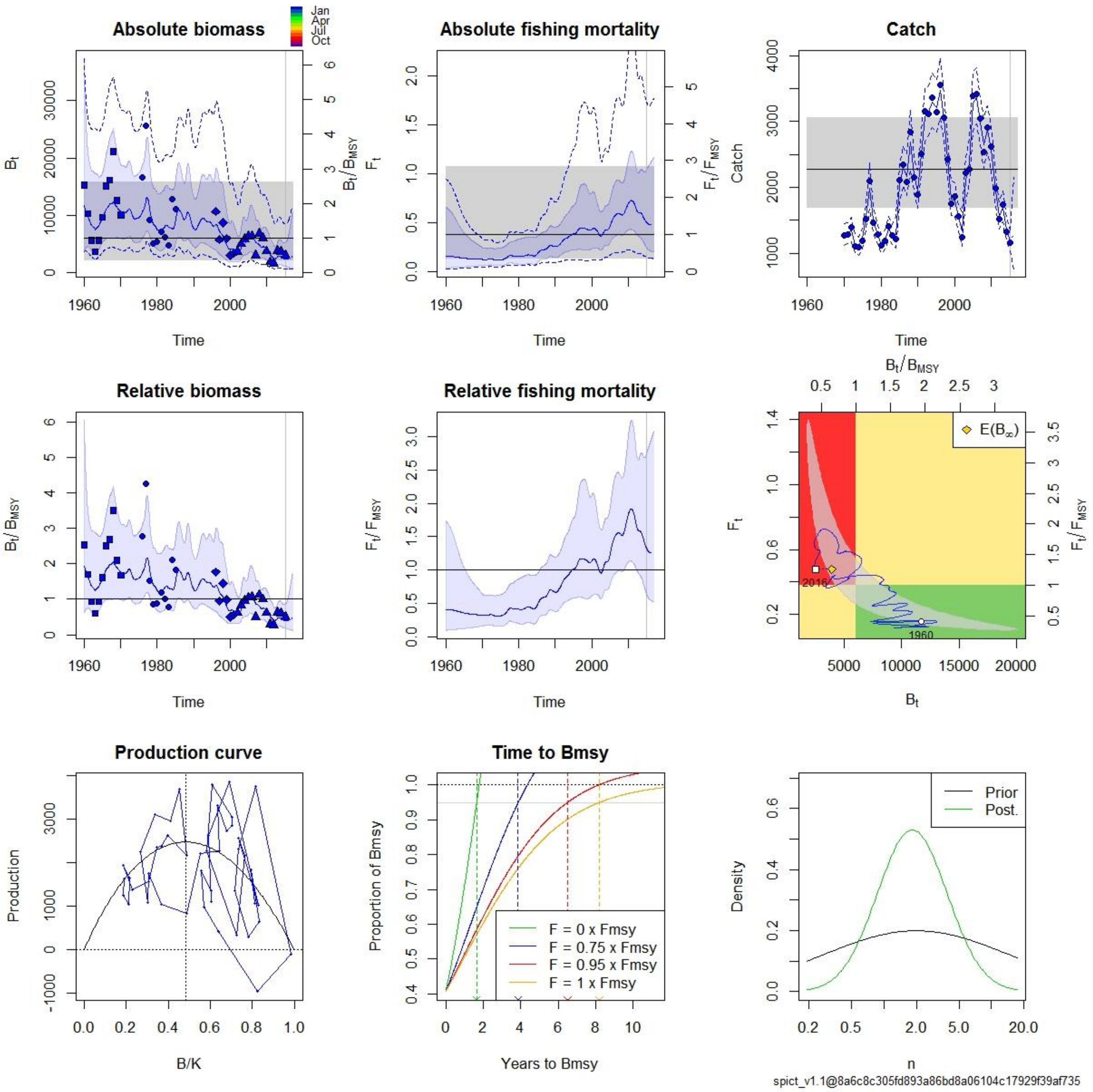


Figure 6.11.2.12. Norway lobster in GSAs 17 and 18. SPiCT model fit for Run #1 with full time series and 4 CPUE indexes.

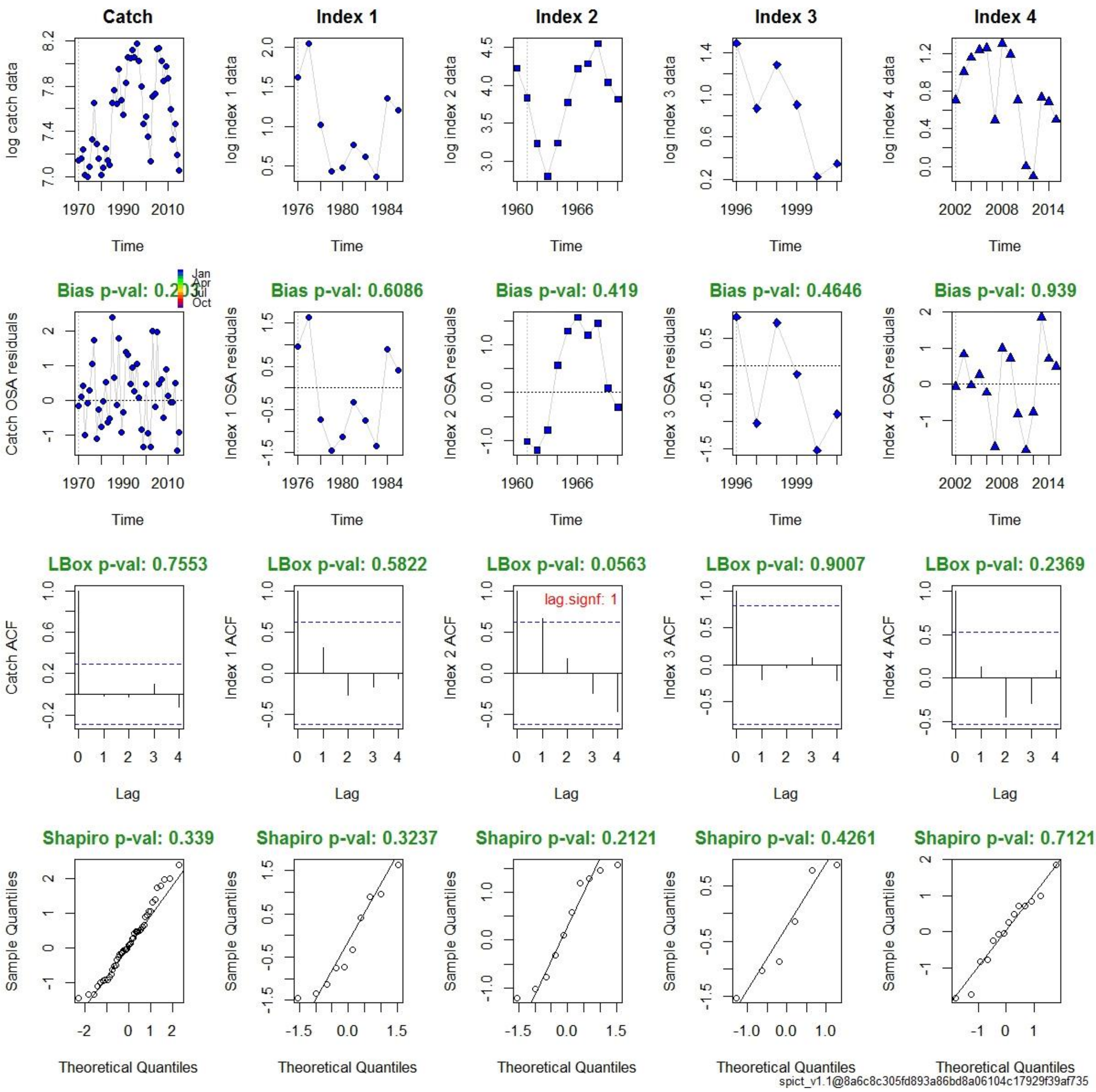


Figure 6.11.2.13. Norway lobster in GSAs 17 and 18. Diagnostics for Model Run # 1 from Norway lobster GSA 17-18 Index 1 = Froglia, Index 2 = Jukic, Index 3 = MEDITS 1995-2001, Index 4 = MEDITS 2002-2005

A retrospective was run with 4 retro years. For production models, the most reliable estimates are in terms of F/Fmsy and B/Bmsy. The retrospective patterns are very consistent across years in terms of B/Bmsy with biomass estimated well below Bmsy. There is have a tendency to higher F in the run without the last 4 years (blue line), this is driven by the MEDITS index that is showing an increase in the last 3 years so the pattern comes from the data and not a fitting issue. F/Fmsy is estimated to be greater than 1 in all runs for all years after 2005. The coherence of the results indicates the retrospective performance is acceptable (Figure 6.11.2.14).

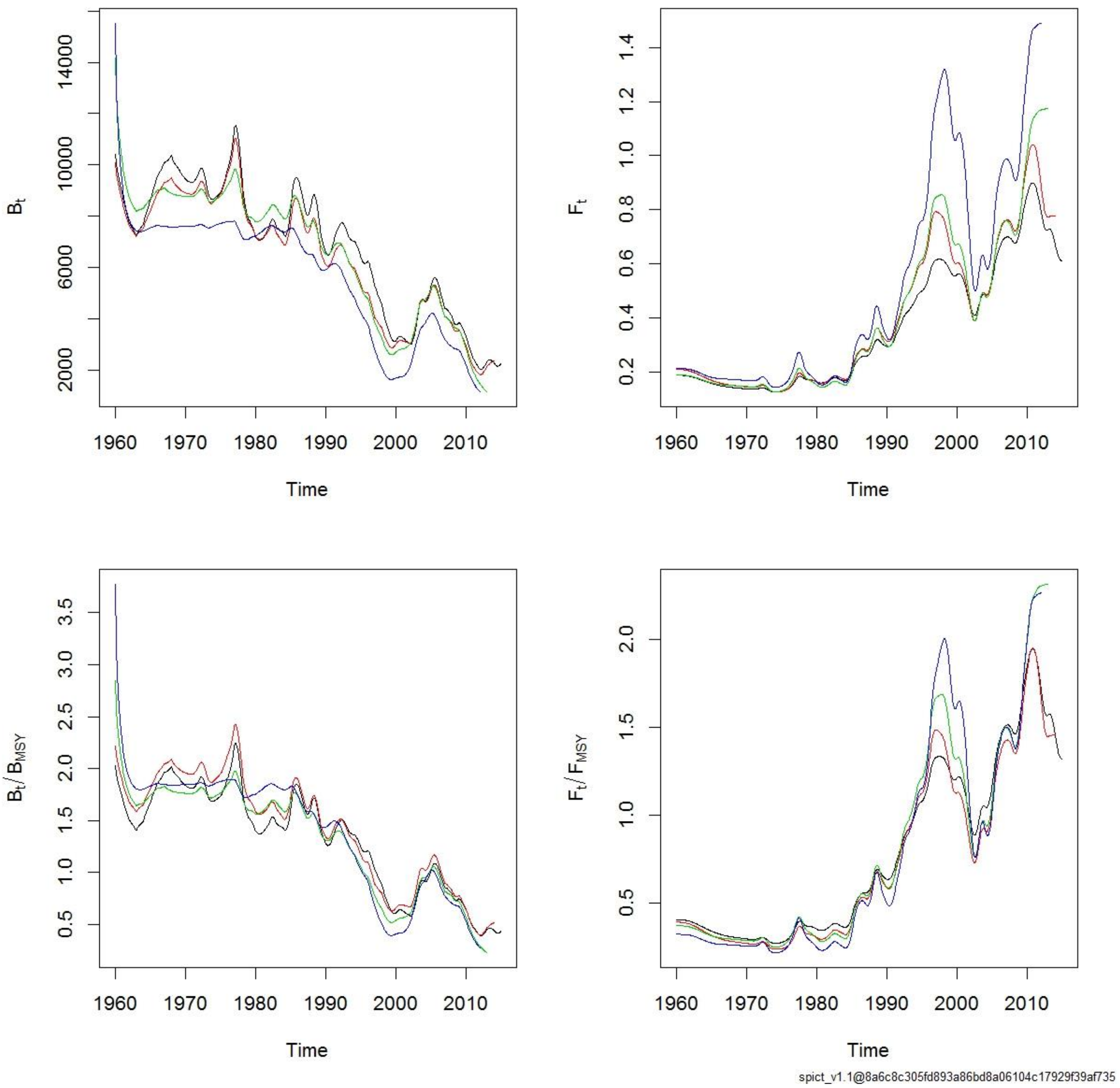


Figure 6.11.2.14. Norway lobster in GSAs 17 and 18. Model Run #1 Retrospective analysis for Nor way lobster in GSA 17-18

Model estimates, reference points and summaries are reported below:

```
Convergence: 0  MSG: relative convergence (4)
Objective function at optimum: 37.1507588
Euler time step (years):  1/16 or 0.0625
Nobs C: 46,  Nobs I1: 10,  Nobs I2: 11,  Nobs I3: 6,  Nobs I4: 14

Priors
     logn  ~  dnorm[log(2), 2^2]
 logalpha  ~  dnorm[log(1), 2^2]
  logbeta  ~  dnorm[log(1), 2^2]

Model parameter estimates w 95% CI
```

```
          estimate         cilow        ciupp    log.est
 alpha1 1.917495e+00    0.8010176 4.590145e+00  0.6510196
 alpha2 1.787724e+00    0.4953207 6.452299e+00  0.5809433
 alpha3 1.242985e+00    0.4249670 3.635606e+00  0.2175159
 alpha4 1.431447e+00    0.6664490 3.074566e+00  0.3586860
 beta   4.323396e-01    0.0922145 2.026986e+00 -0.8385438
 r      7.134599e-01    0.1524988 3.337895e+00 -0.3376290
 rc     7.776017e-01    0.2860512 2.113833e+00 -0.2515408
 rold   8.544158e-01    0.0897083 8.137778e+00 -0.1573374
 m      2.471072e+03 1831.8474828 3.333353e+03  7.8124072
 K      1.314884e+04 5381.2841557 3.212839e+04  9.4840888
 q1     3.022000e-04    0.0001196 7.637000e-04 -8.1043754
 q2     4.503400e-03    0.0017451 1.162100e-02 -5.4029274
 q3     4.132000e-04    0.0001115 1.531300e-03 -7.7916638
 q4     5.421000e-04    0.0001773 1.657500e-03 -7.5201480
 n      1.835027e+00    0.4194070 8.028770e+00  0.6070590
 sdb    2.289657e-01    0.1189800 4.406228e-01 -1.4741830
 sdf    1.570270e-01    0.0718427 3.432150e-01 -1.8513376
 sdi1   4.390406e-01    0.2626238 7.339649e-01 -0.8231634
 sdi2   4.093275e-01    0.1799744 9.309601e-01 -0.8932397
 sdi3   2.846010e-01    0.1353290 5.985246e-01 -1.2566671
 sdi4   3.277523e-01    0.1990209 5.397504e-01 -1.1154970
 sdc    6.788900e-02    0.0209937 2.195383e-01 -2.6898814

Deterministic reference points (Drp)
         estimate        cilow        ciupp   log.est
 Bmsyd 6355.6228720 2399.6388348 16833.342378  8.757095
 Fmsyd    0.3888008    0.1430256     1.056917 -0.944688
 MSYd  2471.0715634 1831.8474828  3333.353202  7.812407
Stochastic reference points (Srp)
        estimate        cilow        ciupp   log.est rel.diff.Drp
 Bmsys 6036.088966 2305.6059855 15802.513629  8.705512  -0.05293724
 Fmsys    0.378494    0.1330157     1.076998 -0.971555  -0.02723121
 MSYs  2281.330120 1703.3968189  3055.346269  7.732514  -0.08317141

States w 95% CI (inp$msytype: s)
                   estimate       cilow        ciupp    log.est
 B_2015.00      2450.3221629 705.5009552 8510.3764322  7.8039748
 F_2015.00         0.5008638   0.1449123    1.7311475 -0.6914210
 B_2015.00/Bmsy    0.4059453   0.1908487    0.8634674 -0.9015368
 F_2015.00/Fmsy    1.3233072   0.6367613    2.7500762  0.2801341

Predictions w 95% CI (inp$msytype: s)
                 prediction       cilow        ciupp    log.est
 B_2016.00      2520.2586469 685.9848541 9259.247649  7.8321168
 F_2016.00         0.4791119   0.1346813    1.704381 -0.7358211
 B_2016.00/Bmsy    0.4175317   0.1546245    1.127458 -0.8733947
 F_2016.00/Fmsy    1.2658375   0.5483733    2.921996  0.2357340
 Catch_2016.00  1282.4137797 765.6763992 2147.885326  7.1564993
 E(B_inf)       3936.9308577          NA          NA  8.2781567
```

Model run #2

Input data GSA 17-18, Landings 1990-2015, MEDITS a 1995-2001 and MEDITS b 2002-2015. MEDITS was explicitly split in two distinct tuning indexes to account for the difference of the 1995-2001 index being derived only on the Italian side in GSA 17 from an index covering the whole GSA 18 starting in 2002 (Figure 6.11.2.15).

Initial model runs were performed with Landings starting in 1970 and in 1980; however the models failed to converge due to the unbalance between number of data points in landings and in MEDITS. By trimming the length of the Landings time series to a start year in 1990, the model converges.

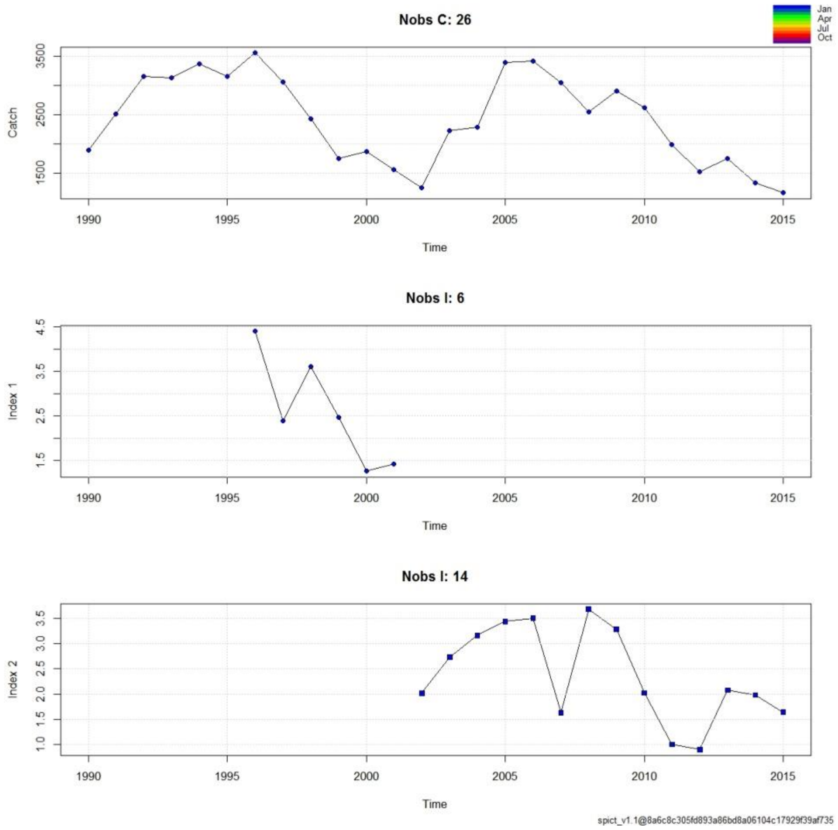


Figure 6.11.2.15. Norway lobster in GSAs 17 and 18. Input Data from Norway lobster GSA 17-18 Model run #2. Index 1 = MEDITS 1995-2001, Index 2 = MEDITS 2002-2005.

SPiCT was run with the default prior settings and informative priors for initial parameter estimates. The model converged and the diagnostic results (Residuals, Auto correlation and Shapiro p-values) are acceptable for both catches and the 2 tuning indexes, however in comparison to Model Run #1 the QQ plots are less normal and there are heavy tails (Figure 6.11.2.16 and 6.11.2.17).

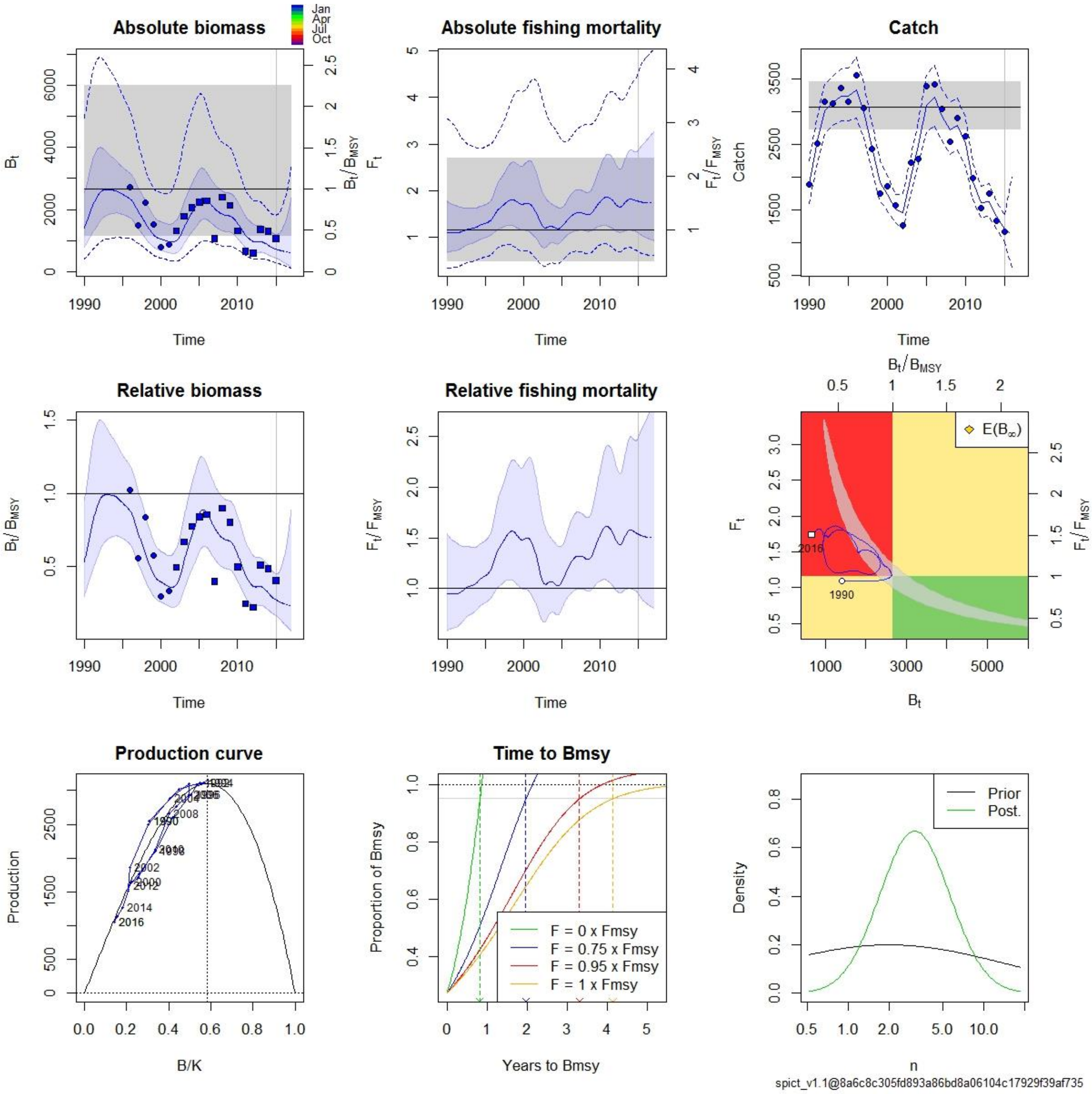


Figure 6.11.2..16. Norway lobster in GSAs 17 and 18. SPiCT model fit for Run #2 with full time series and 2 CPUE indexes.

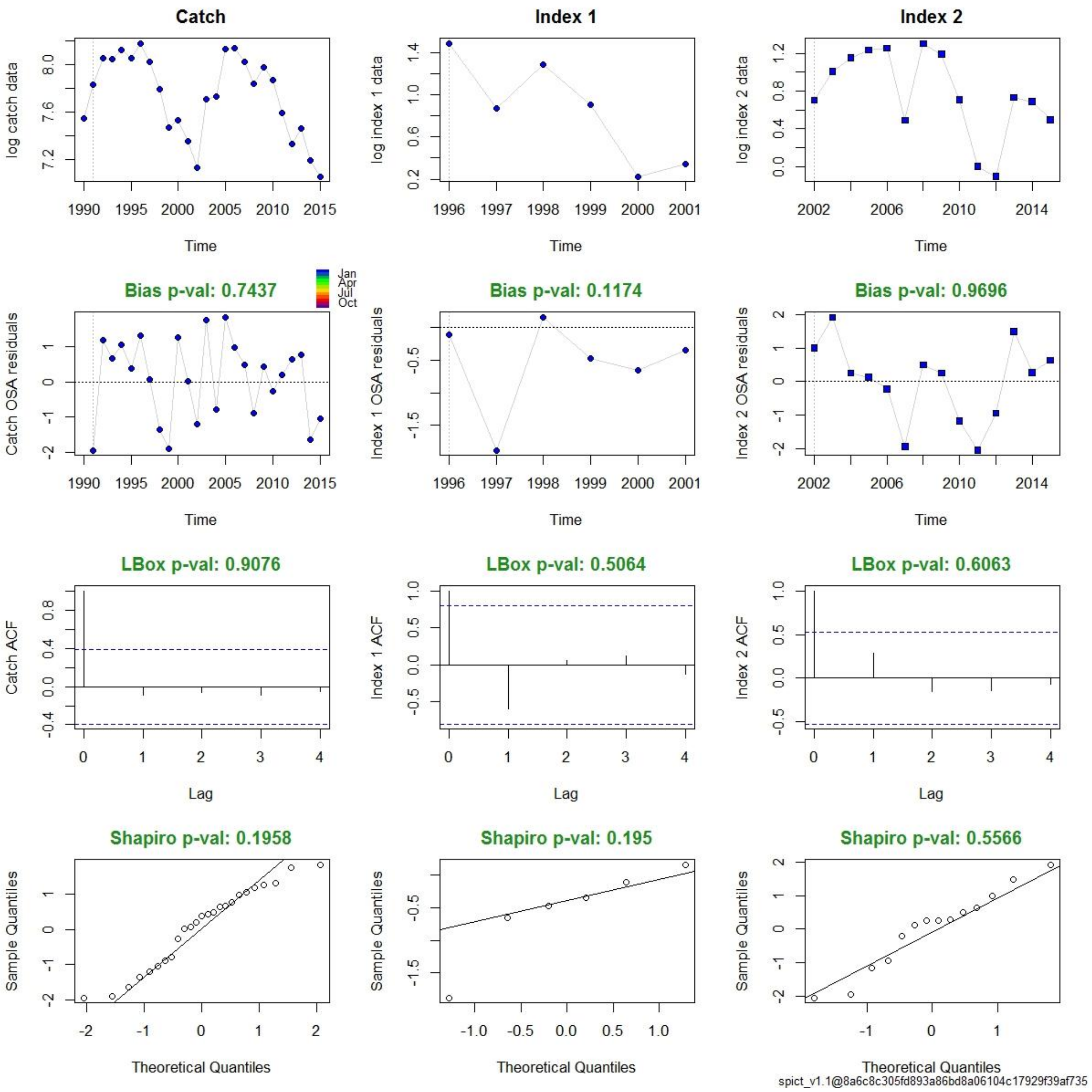


Figure 6.11.2.17. Norway lobster in GSAs 17 and 18. Diagnostics for Model Run # 2 from Norway lobster GSA 17-18 Index 1 = MEDITS 1995-2001, Index 2 = MEDITS 2002-2005

A retrospective was run with 4 retro years. The retrospective patterns are consistent across years in terms of B/Bmsy but don't present a good pattern in F/Fmsy for the 1980's and the most recent years (Figure 6.11.2.18). The performance with the reduced data set is poorer than for Run 1 on internal diagnostic criteria retrospective performance.

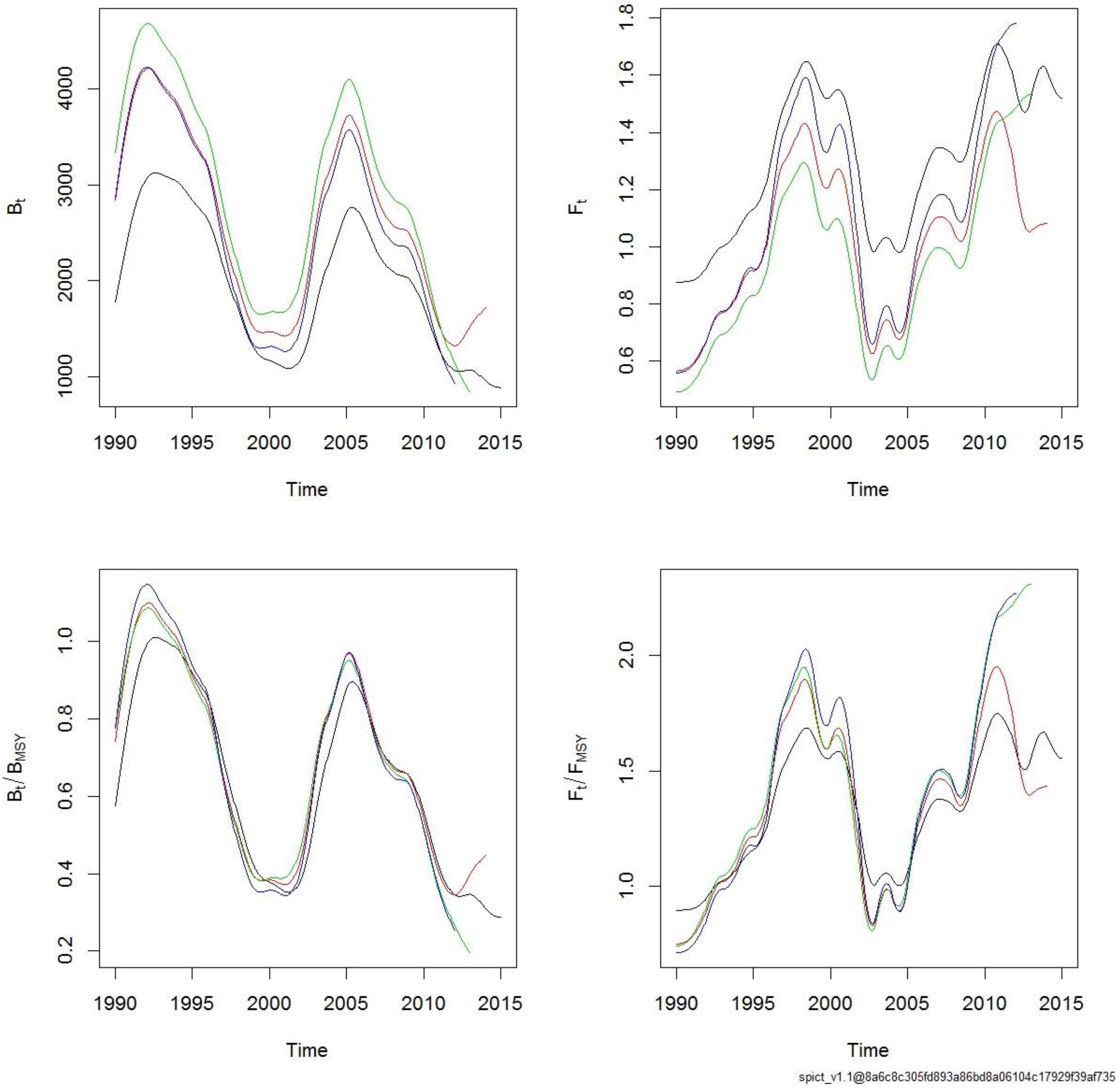


Figure 6.11.2.18 Norway lobster in GSAs 17 and 18. Model Run #2 Retrospective analysis for Norway lobster in GSA 17-18

Model estimates, reference points and summaries are reported below:

```
 Convergence: 0  MSG: relative convergence (4)
Objective function at optimum: 20.0135067
Euler time step (years):  1/16 or 0.0625
Nobs C: 26,  Nobs I1: 6,  Nobs I2: 14

Priors
     logn  ~  dnorm[log(2), 2^2]
 logalpha  ~  dnorm[log(1), 2^2]
  logbeta  ~  dnorm[log(1), 2^2]
```

```
Model parameter estimates w 95% CI
           estimate        cilow        ciupp    log.est
 alpha1    3.4178546    0.6412682 1.821661e+01  1.2290130
 alpha2    4.7431949    0.9903669 2.271673e+01  1.5567109
 beta      0.6669665    0.1889165 2.354714e+00 -0.4050154
 r         3.5635925    0.7919862 1.603461e+01  1.2707692
 rc        2.3021149    1.0003197 5.298039e+00  0.8338282
 rold      1.7002446    0.6546890 4.415580e+00  0.5307721
 m      3099.5042082 2756.7245024 3.484906e+03  8.0389974
 K      4616.9923409 1858.9119250 1.146726e+04  8.4374988
 q1        0.0016174    0.0006989 3.743300e-03 -6.4269082
 q2        0.0015388    0.0006313 3.750800e-03 -6.4767668
 n         3.0959293    0.9614066 9.969537e+00  1.1300881
 sdb       0.0753097    0.0158473 3.578875e-01 -2.5861459
 sdf       0.1363302    0.0561498 3.310056e-01 -1.9926757
 sdi1      0.2573977    0.1416539 4.677144e-01 -1.3571329
 sdi2      0.3572087    0.2378325 5.365040e-01 -1.0294350
 sdc       0.0909277    0.0504905 1.637505e-01 -2.3976911

Deterministic reference points (Drp)
         estimate        cilow      ciupp  log.est
 Bmsyd 2692.745004 1223.5239240 5926.22303 7.898316
 Fmsyd    1.151058    0.5001598    2.64902 0.140681
 MSYd  3099.504208 2756.7245024 3484.90621 8.038997
Stochastic reference points (Srp)
         estimate        cilow       ciupp   log.est rel.diff.Drp
 Bmsys 2662.723792 1177.8695249 6019.425616 7.8871049 -0.011274625
 Fmsys    1.153549    0.4922122    2.703459 0.1428433  0.002159896
 MSYs  3071.657097 2731.2754105 3454.458412 8.0299725 -0.009065827

States w 95% CI (inp$msytype: s)
                  estimate       cilow        ciupp    log.est
 B_2015.00      720.2359563 284.7517900 1821.7263274  6.5795789
 F_2015.00        1.7705933   0.6898529    4.5444478  0.5713147
 B_2015.00/Bmsy   0.2704884   0.1625691    0.4500485 -1.3075260
 F_2015.00/Fmsy   1.5349095   0.9446854    2.4938960  0.4284714

Predictions w 95% CI (inp$msytype: s)
                 prediction       cilow        ciupp    log.est
 B_2016.00       653.2189346 194.2291374 2196.8638798  6.4819123
 F_2016.00         1.7405145   0.6229314    4.8631210  0.5541808
 B_2016.00/Bmsy    0.2453198   0.1106335    0.5439744 -1.4051925
 F_2016.00/Fmsy    1.5088345   0.8555057    2.6610947  0.4113375
 Catch_2016.00  1100.3840343 606.0539585 1997.9162019  7.0034145
 E(B_inf)                NaN          NA           NA        NaN
```

Model run #3

Input data GSA 17-18, Landings 1990-2015 and MEDITS b 2002-2015 (Figure 6.11.2.19). Initial model runs were performed with Landings starting in 1970 and in 1980; however the models failed to converge due to the unbalance between number of data points in landings and in MEDITS. By trimming the length of the landings time series, the model converges.

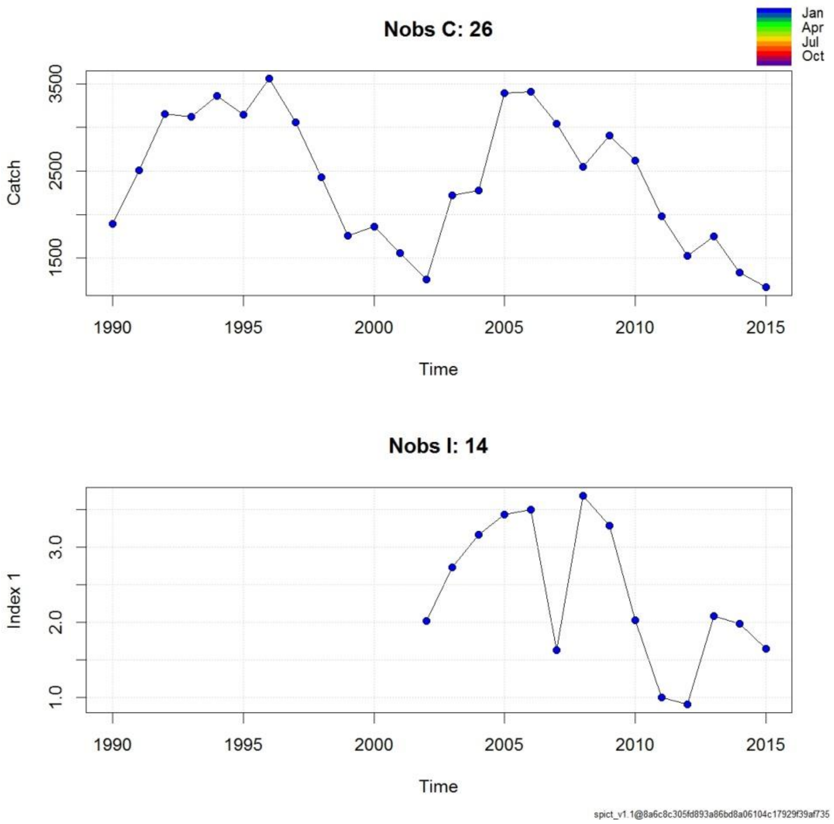


Figure 6.11.2.19. Norway lobster in GSAs 17 and 18. Input Data from Norway lobster GSA 17-18 Model run #3 Index 1 = MEDITS 2002-2005.

The model converged and the diagnostic results (Residuals, Auto correlation and Shapiro p-values) are acceptable for both catches and the tuning index, however in comparison to Model Run #1 the QQ plots are less normal and there are heavy tails (Figures 6.11.2.20 and 6.11.2.21).

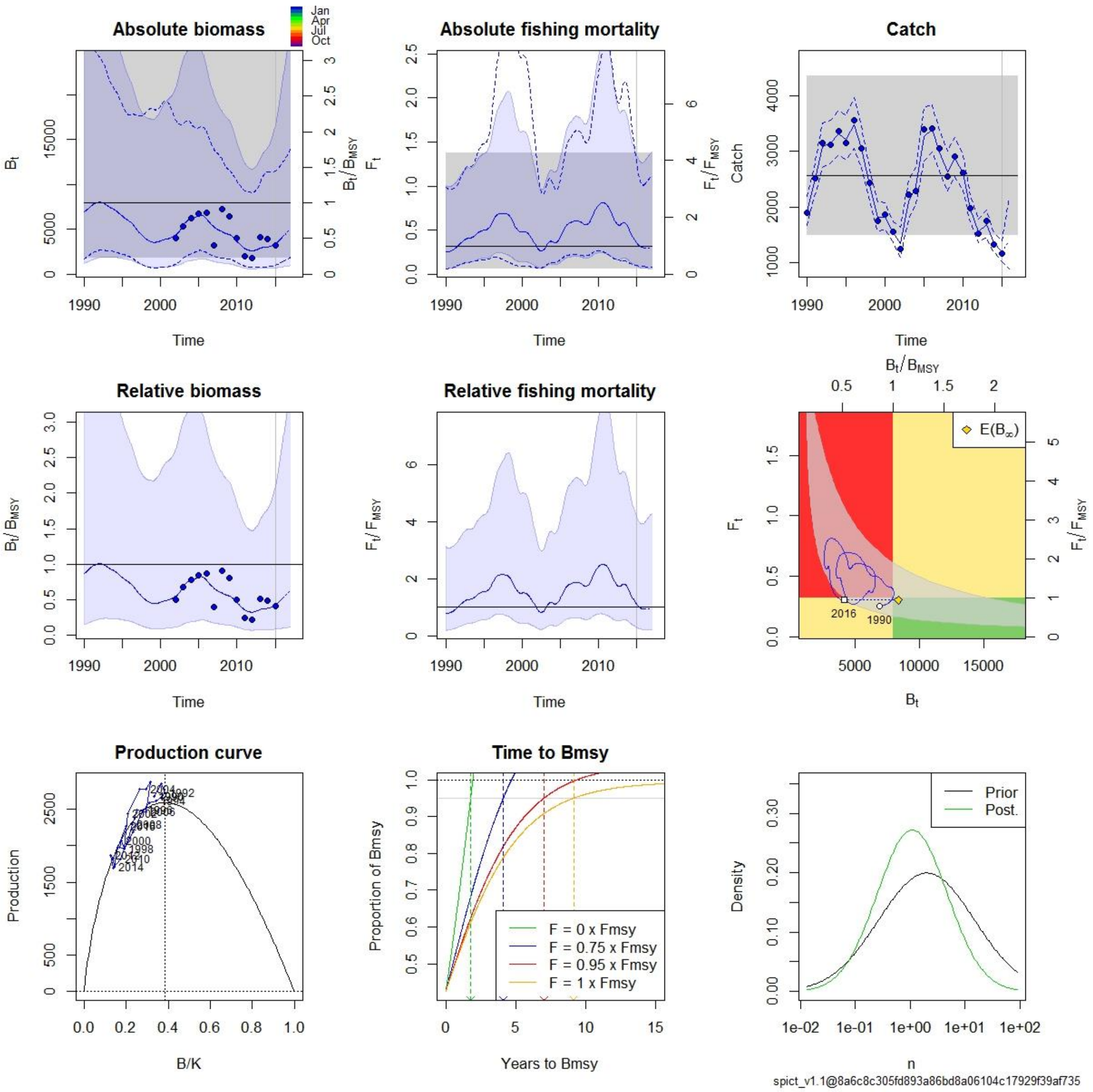


Figure 6.11.2.20. Norway lobster in GSAs 17 and 18. SPiCT model fit for Run #3 with full time series and 2 CPUE indexes.

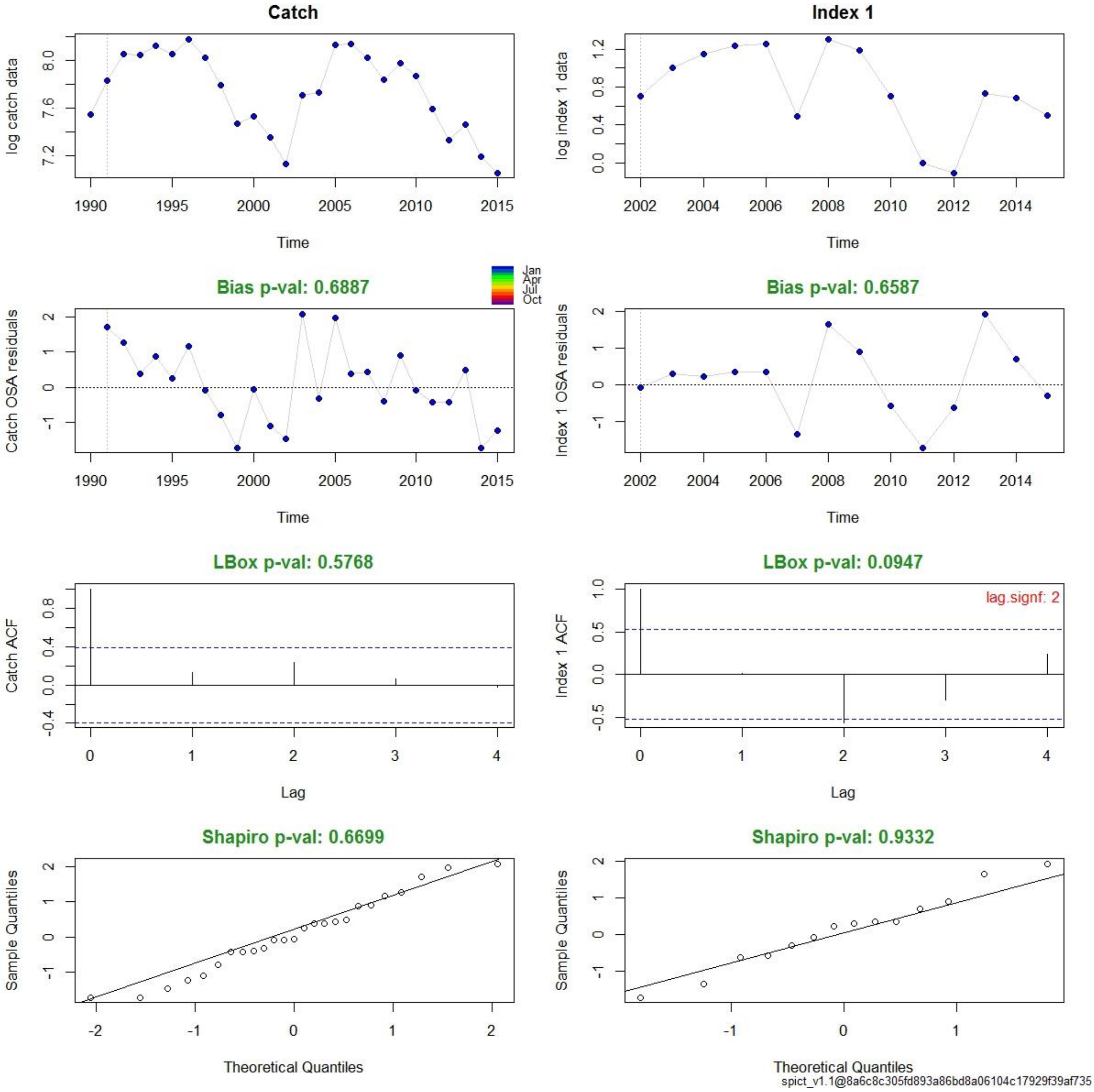


Figure 6.11.2.21. Norway lobster in GSAs 17 and 18. Diagnostics for Model Run # 3 from Norway lobster GSA 17-18 Index 1 = MEDITS 1995-2001, Index 2 = MEDITS 2002-2005

A retrospective was run with 4 retro years. The retrospective patterns are consistent across years in terms of B/Bmsy and don't present a good pattern in F/Fmsy in the most recent years (Figure 6.11.2.22). The performance with the further reduced data set is also poorer than for Run 1 on internal diagnostic criteria retrospective performance and the precision of the estimates of F and SSB are much wider.

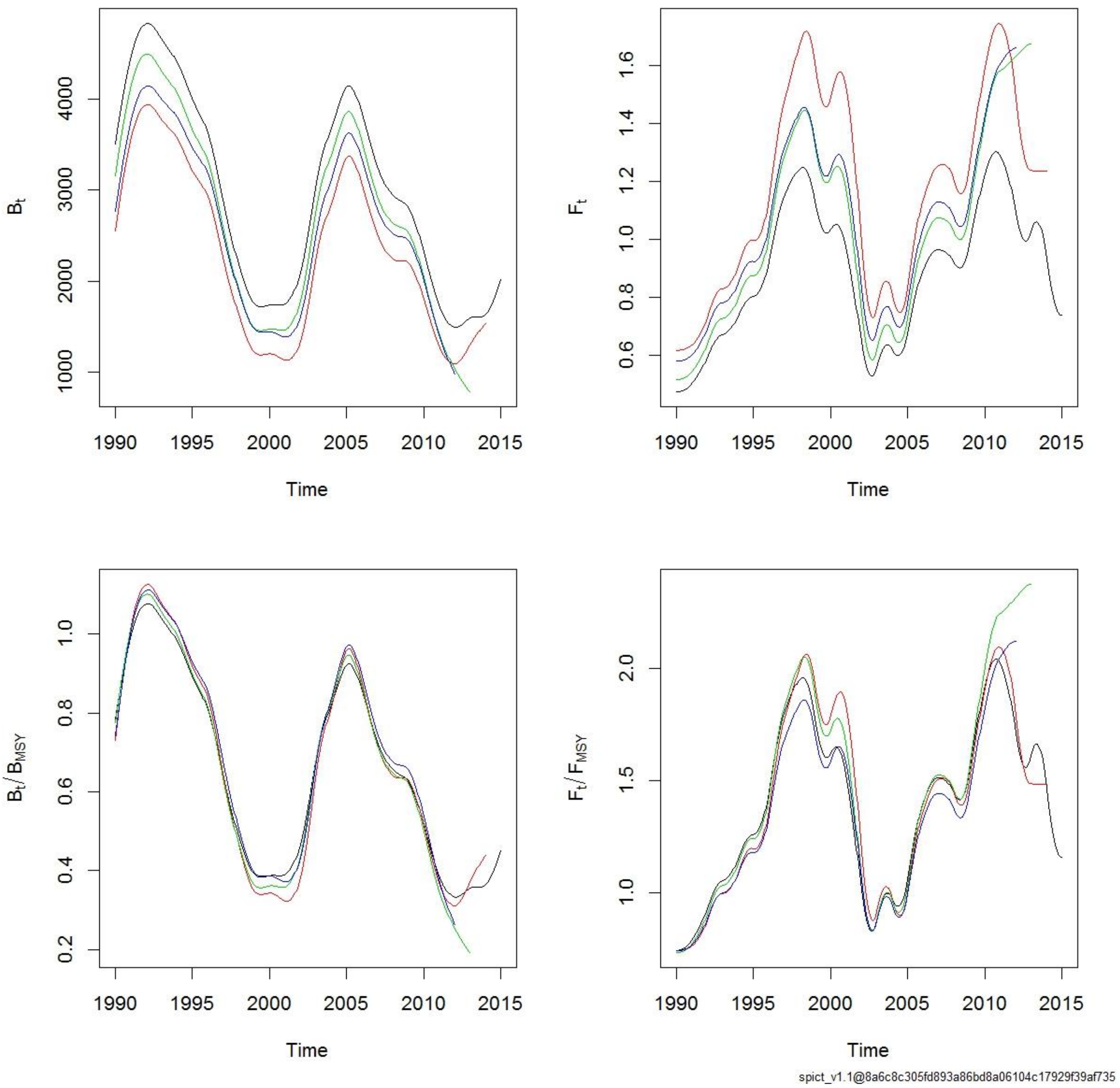


Figure 6.11.2.22. Norway lobster in GSAs 17 and 18. Model Run #3 Retrospective analysis for Norway lobster in GSA 17-18

Model estimates, reference points and summaries are reported below, estimates for F/Fmsy and B/Msy represent state in the beginning of the year:

```
Convergence: 0  MSG: relative convergence (4)
Objective function at optimum: 17.3687856
Euler time step (years):  1/16 or 0.0625
Nobs C: 26,  Nobs I1: 14

Priors
     logn  ~  dnorm[log(2), 2^2]
 logalpha  ~  dnorm[log(1), 2^2]
  logbeta  ~  dnorm[log(1), 2^2]
```

```
Model parameter estimates w 95% CI
            estimate        cilow        ciupp    log.est
 alpha  3.087793e+00    0.2400502 3.971863e+01  1.1274566
 beta   2.697733e-01    0.0543144 1.339932e+00 -1.3101735
 r      3.530957e-01    0.0063032 1.977978e+01 -1.0410162
 rc     6.460732e-01    0.1493773 2.794338e+00 -0.4368425
 rold   3.794621e+00    0.0000000 3.822333e+13  1.3335845
 m      2.589705e+03 1548.8422843 4.330054e+03  7.8592991
 K      2.085735e+04 1578.2561835 2.756390e+05  9.9454617
 q      5.098000e-04    0.0001736 1.496400e-03 -7.5815837
 n      1.093052e+00    0.0614974 1.942783e+01  0.0889735
 sdb    9.801840e-02    0.0081009 1.185987e+00 -2.3225998
 sdf    2.479537e-01    0.1345726 4.568613e-01 -1.3945134
 sdi    3.026606e-01    0.1950650 4.696046e-01 -1.1951432
 sdc    6.689130e-02    0.0195959 2.283360e-01 -2.7046869

Deterministic reference points (Drp)
           estimate        cilow        ciupp   log.est
 Bmsyd 8016.7531548 1821.0338062 35292.222982  8.989289
 Fmsyd    0.3230366    0.0746886     1.397169 -1.129990
 MSYd  2589.7046258 1548.8422843  4330.053561  7.859299
Stochastic reference points (Srp)
           estimate        cilow        ciupp   log.est  rel.diff.Drp
 Bmsys 7944.3888691 1835.4555567 34385.640270  8.980221 -0.0091088549
 Fmsys    0.3228214    0.0756224     1.378079 -1.130656 -0.0006666007
 MSYs  2564.6030479 1512.2360087  4349.313702  7.849559 -0.0097877049

States w 95% CI (inp$msytype: s)
                   estimate       cilow        ciupp    log.est
 B_2015.00      3371.6108953 990.5154456 11476.610567  8.1231459
 F_2015.00         0.3573282   0.1017428     1.254963 -1.0291006
 B_2015.00/Bmsy    0.4244015   0.0866521     2.078618 -0.8570752
 F_2015.00/Fmsy    1.1068914   0.2931317     4.179720  0.1015555

Predictions w 95% CI (inp$msytype: s)
                 prediction        cilow        ciupp    log.est
 B_2016.00      4161.0748316 1385.6873498 12495.274462  8.3335287
 F_2016.00         0.3034761    0.0901838     1.021222 -1.1924523
 B_2016.00/Bmsy    0.5237753    0.1002787     2.735780 -0.6466925
 F_2016.00/Fmsy    0.9400744    0.2222995     3.975447 -0.0617962
 Catch_2016.00  1390.2206079  892.1915355  2166.253839  7.2372177
 E(B_inf)       8372.7692590           NA           NA  9.0327400
```

CONCLUSIONS

All 3 models converged, although with less tuning indices time series of catches are of different length. All models show consistently a low B/Bmsy with the last year being amongst the lowest

point of the series. In terms of F/Fmsy all models estimate it as being above the reference point of Fmsy in the last years, although some perceive a better state than other.
Taking into account the retrospective patterns, overall residual fit the best fitting most informative model is model #1. Given that this model run's uses the most complete data set fitted to the longest time series available, it is considered the best model as it covers periods with high biomass and low F, some stock declines and recoveries. It is considered particularly important for surplus production models to include a long time series of catch, and a full range of stock dynamics, model 1 fulfils these criteria, and is considered as a good basis for advice.

Based on **model run #1** using mean value by year, refered to the stockastic reference points (B_{MSYs} F_{MSYs}**),** the current stock status is , F_{2015}/F_{MSYs} = 1.287 and B_{2015}/B_{MSYs} = 0.403. When refered to the determinsitc reference points, the stock status in 2015, , is F_{2015}/F_{MSYd}= 1.253. and B_{2015}/B_{MSYd} = 0.383

6.11.3 REFERENCE POINT

The SPiCT model provides output set directly in the context of MSY, and the results are more precise when considered relative the estimated MSY parameters. The MSY parameters themselves are estimated by the model, however, these are less precise than the F/Fmsy and B/Bmsy results. Based on model run #1 Fmsy from stochastic reference points is F_{MSYs} = 0.378 y^{-1} (0.133 - 1.077) and B_{MSYs} = 6036.088 t (2305.606 - 15802.514) , while the deterministic reference points are F_{MSYd} = 0.388 and B_{MSYd} = 6355 t.

Based on these results STECF-EWG 16-17 considers the stock has been depleted well below Bmsy and been overexploited (F>Fmsy) in the last years.

6.11.4 SHORT TERM FORECAST

The SPiCT model was used to carry out a short term forecast with the following conditions:-

```
Observed interval, index:  1960.00 - 2015.00
Observed interval, catch:  1970.00 - 2016.00

Fishing mortality (F) prediction: 2020.00
Biomass (B) prediction:           2020.00
Catch (C) prediction interval:    2019.00 - 2020.00

Predictions
                          C       B     F B/Bmsy F/Fmsy perc.dB perc.dF
1. Keep current catch 1162.1  2008.6 0.576  0.333  1.523   -20.3    20.3
2. Keep current F     1690.3  3645.3 0.479  0.604  1.266    44.6     0.0
3. Fish at Fmsy       1693.8  4711.5 0.378  0.781  1.000    86.9   -21.0
4. No fishing            4.6 10453.4 0.000  1.732  0.001   314.8   -99.9
5. Reduce F 25%       1680.0  4937.1 0.359  0.818  0.949    95.9   -25.0
6. Increase F 25%     1565.8  2624.8 0.599  0.435  1.582     4.1    25.0

95% CIs of absolute predictions
                        C.lo   C.hi   B.lo    B.hi  F.lo  F.hi
1. Keep current catch 1029.6 1311.6    NaN     NaN   NaN   NaN
2. Keep current F      583.1 4900.2  631.4 21045.7 0.117 1.963
3. Fish at Fmsy        668.2 4294.0 1168.1 19003.4 0.092 1.551
4. No fishing            1.5   14.7 5553.1 19678.0 0.000 0.002
5. Reduce F 25%        671.1 4206.2 1301.2 18732.7 0.088 1.472
6. Increase F 25%      403.1 6083.0  275.0 25051.8 0.146 2.454

95% CIs of relative predictions
```

```
                         B/Bmsy.lo B/Bmsy.hi F/Fmsy.lo F/Fmsy.hi
1. Keep current catch          NaN       NaN     1.030     2.253
2. Keep current F            0.103     3.552     0.448     3.576
3. Fish at Fmsy              0.186     3.277     0.354     2.825
4. No fishing                0.807     3.718     0.000     0.004
5. Reduce F 25%              0.206     3.244     0.336     2.682
6. Increase F 25%            0.046     4.120     0.560     4.470
```

Full time series of forecasts are outlined in Table 6.11.4.1

Table 6.11.4.1 Norway lobster in GSAs 17-18. Short term forecasts of status quo and different fishing mortalities reductions

Forecast Scenario	Year	Fishing mortality (F)	Biomass (B)	Catch
Keep current catch	2015	0.574294	2056.933	1181.317
	2016	0.582	1997.183	1162.351
	2017	0.587687	1980.898	1164.145
	2018	0.587566	1980.012	1163.385
	2019	0.582022	1996.654	1162.08
	2020	0.572077	2042.376	1168.342
Keep current F	2015	0.487061	2434.904	1185.877
	2016	0.479112	2676.647	1282.414
	2017	0.479112	2994.282	1434.597
	2018	0.479112	3280.054	1571.514
	2019	0.479112	3528.001	1690.309
	2020	0.479113	3736.52	1790.214
Fish at Fmsy	2015	0.487061	2434.904	1185.877
	2016	0.378494	2802.42	1060.7
	2017	0.378494	3404.081	1288.425
	2018	0.378494	3973.169	1503.822
	2019	0.378495	4475.215	1693.845
	2020	0.378495	4892.05	1851.615
No fishing	2015	0.487061	2434.904	1185.877
	2016	0.000479	3347.558	1.604147
	2017	0.000479	5449.536	2.612275
	2018	0.00048	7721.42	3.702541
	2019	0.00048	9646.361	4.627109
	2020	0.00048	10975.66	5.266487
Reduce F 25%	2015	0.487061	2434.904	1185.877
	2016	0.359334	2827.226	1015.918
	2017	0.359334	3487.824	1253.294
	2018	0.359334	4118.236	1479.823
	2019	0.359334	4675.441	1680.047
	2020	0.359335	5136.108	1845.582

Increase F 25%	2015	0.487061	2434.904	1185.877
	2016	0.59889	2536.298	1518.964
	2017	0.59889	2567.021	1537.363
	2018	0.59889	2592.882	1552.852
	2019	0.59889	2614.577	1565.845
	2020	0.598891	2632.725	1576.714

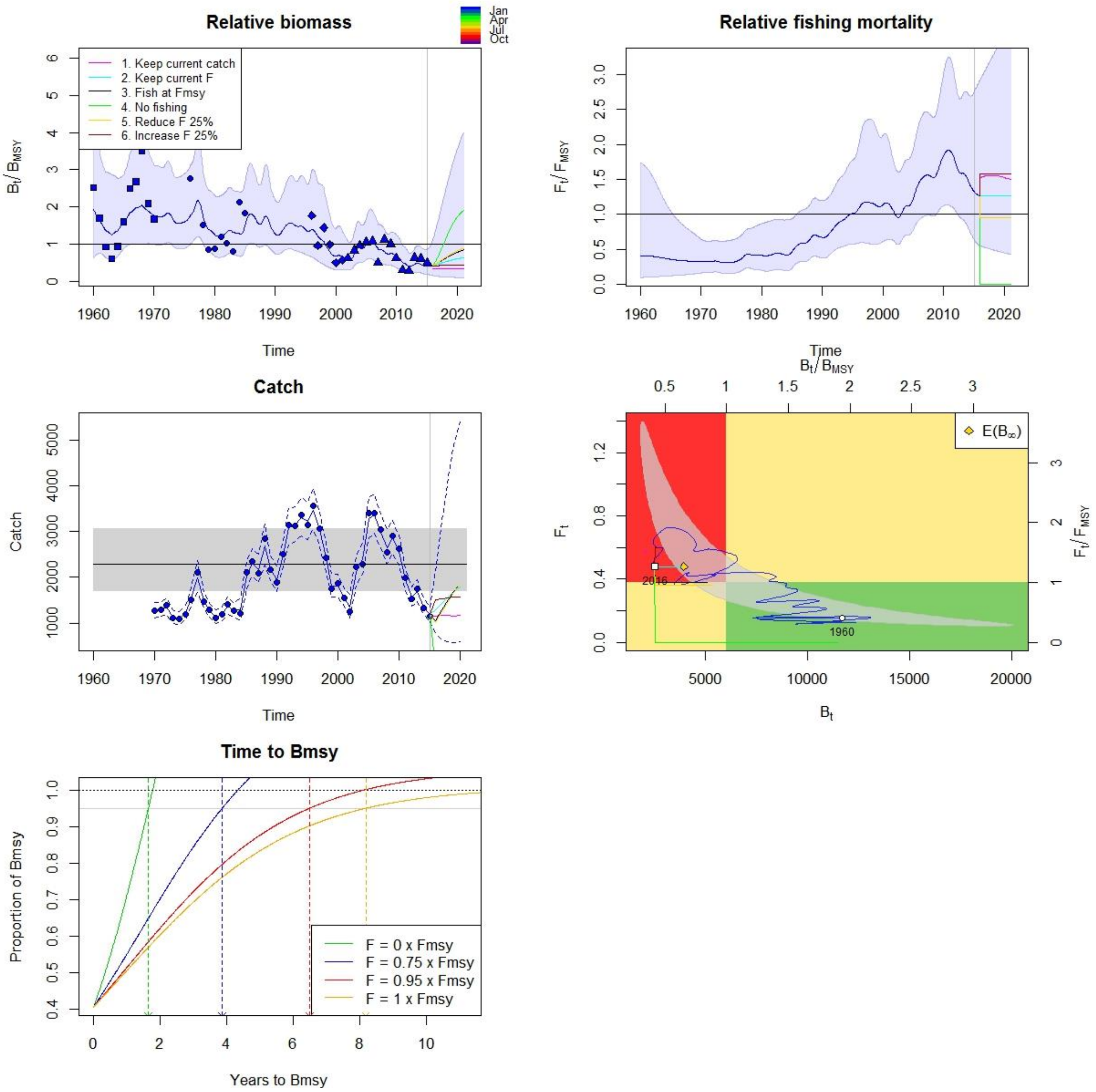


Figure 6.11.4.1 Norway lobster in GSAs 17 and 18. Short term forecast for the period 2017-2020 according to different scenarios: 1 keep current catch, 2, keep current F, 3 fishing at Fmsy, 4 no fishing, 5 reduce F by 25%, 6 increase F by 25%.

6.11.5 QUALITY AND PROPOSALS FOR FUTURE ASSESSMENTS

Being able to split the catch numbers in the Pomo and outside Pomo area would be beneficial for age/length based assessments. According to the Italian DCF workplan 2011-2014 (https://datacollection.jrc.ec.europa.eu/np/2014/-/document_library_display/z9Yv/view/688307/38422?_110_INSTANCE_z9Yv_redirect=https%3A%2F%2Fdatacollection.jrc.ec.europa.eu%2Fnp%2F2014%3Fp_p_id%3D110_INSTANCE_z9Yv%26p_p_lifecycle%3D0%26p_p_state%3Dnormal%26p_p_mode%3Dview%26p_p_col_id%3Dcolumn-2%26p_p_col_count%3D1), the DCF sampling in GSA 17 of the OTB gear had a target sampling of 78 fishing trips each year on a quarterly basis in the whole Italian side of GSA 17 out of 76525,51 average total no. of trips in the reference years. The 78 fishing trips are split in 36 concurrent at sea and 48 concurrent at market sampling. This means 9 non unique fishing trips had to be sampled at sea in GSA 17 each quarter. If catches were to be split a posteriori between Pomo area and outside Pomo on a 50% -50% basis, at most 4.5 trips would be sampled quarterly in Pomo which would arguably carry no significant sampling levels for a reconstruction of catch at length in the different areas. The EWG has no access to primary sampling data, but it might also be the case that no fishing trips are sampled in the Pomo pit area.

6.12 DEEP-WATER ROSE SHRIMP IN GSA 1

6.12.1 DATA GATHERING OF DEEP-WATER ROSE SHRIMP IN GSA 1

6.12.1.1 Stock Identity and Biology

Due to a lack of information about the structure of the deep-water rose shrimp population in the western Mediterranean, this stock was assumed to be confined within the boundaries of the GSA 01 (Figure 6.12.1.1.1).

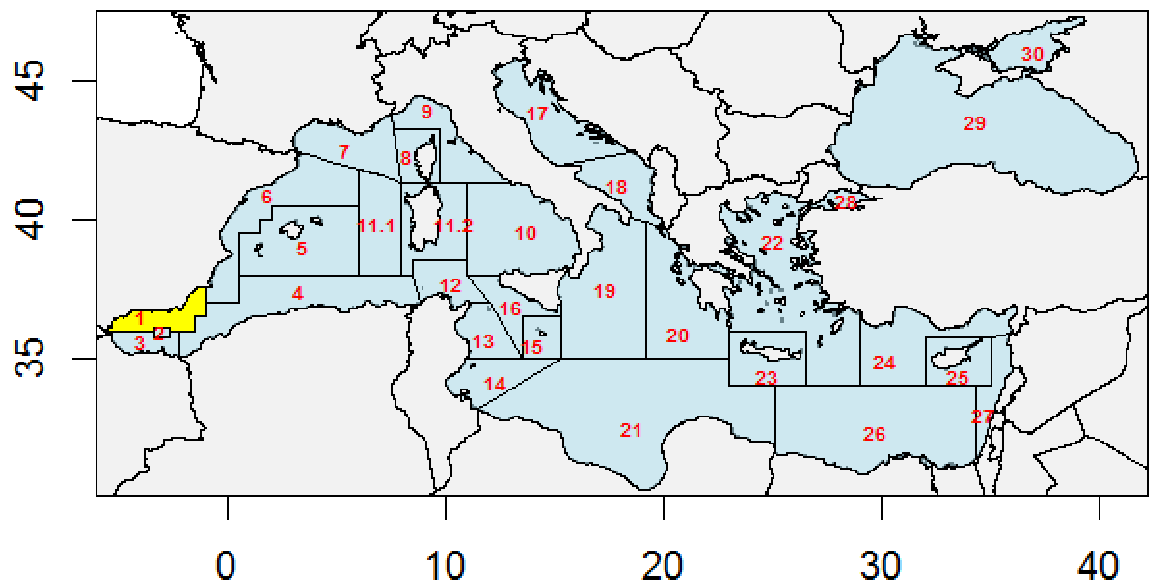


Figure 6.12.1.1.1. Geographical location of GSA 1.

The deep-water rose shrimp is a demersal species that is found on sandy and muddy bottoms in the Mediterranean Sea and the Atlantic Ocean south of the Iberian peninsula, being more abundant at depths between 150 m and 400 m (García-Rodríguez et al., 2007).This species is characterized by a differential growth pattern, with females reaching larger sizes. The reproductive period takes place throughout all the year, with some peaks of activity especially in summer (García-Rodríguez et al., 2009). The species feeds on a great variety of prey, its main prey being annelid worms (polychaetes) and foraminiferans (Sobrino et al., 2005).

Growth

Since for this area there is not an indication of growth parameters in the DCF database, those estimated for the GSA 6 by García-Rodríguez et al. (2009) and used in the previous assessment (STECF EWG 13-09) were applied, as reported in the following Table and Figure.

Table 6.12.1.1.1. Deep-water rose shrimp in GSA 1. Growth parameters used in the assessment.

	Growth parameters			Length-weight relationship	
	Linf	K	t0	a	b
Sex combined	45	0.3903	0.1019	0.003055	2.490608

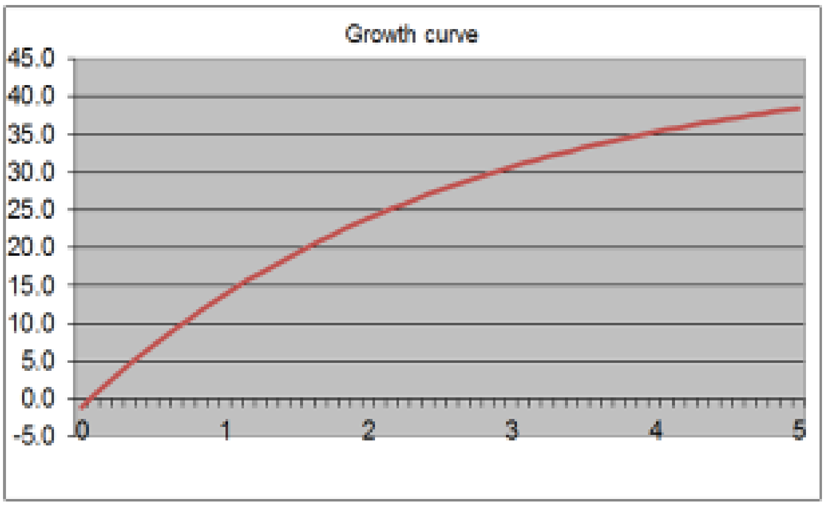


Figure. 6.12.1.1.2. Deep-water rose shrimp in GSA 01. Von Bertalanffy curves used in the analysis.

Maturity

The maturity vector was also obtained from the previous assessment, as calculated by García-Rodríguez et al. (2009) and reported in Table 6.12.1.1.2.

Table 6.12.1.1.2. Deep-water rose shrimp in GSA 1. Maturity vector at age.

Age	0	1	2	3	4+
Maturity	0	0.13	0.50	0.88	0.99

Natural mortality

The natural mortality vector was estimated using PRODBIOM (Abella *et al*., 1997). A sex-combined curve has been estimated, using the parameters shown in Table 6.12.1.1.1. The natural mortality vector by age is reported in table. 6.12.1.1.3.

Table 6.12.1.1.3. Deep-water rose shrimp in GSA 1. Natural mortality vector by age.

Age	0	1	2	3	4+
M	1.72	0.97	0.82	0.76	0.72

6.12.1.2 Catch data

General description of the fisheries

Deep-water rose shrimp is a target species for around 170 trawling vessels (2015) operating on the upper slope and it is one of the most important crustacean species for the trawl fisheries of GSA 01. No artisanal boats target this species.

Landings

Landings of deep-water rose shrimp in GSA 01 come exclusively from trawling. During the last 10 years the total landings showed important oscillations, ranging between a minimum of 38 tons in 2006 and a maximum of 256 tons in 2009, with another peak in 2012 (243 tons) (Table and Figure 6.12.1.2.1).

Table 6.12.1.2.1. Deep-water rose shrimp in GSA 01. Annual landings (t) from trawlers, as provided through the official DCF.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Landings	187	118	103	38	56	109	254	98	172	242	149	100	109

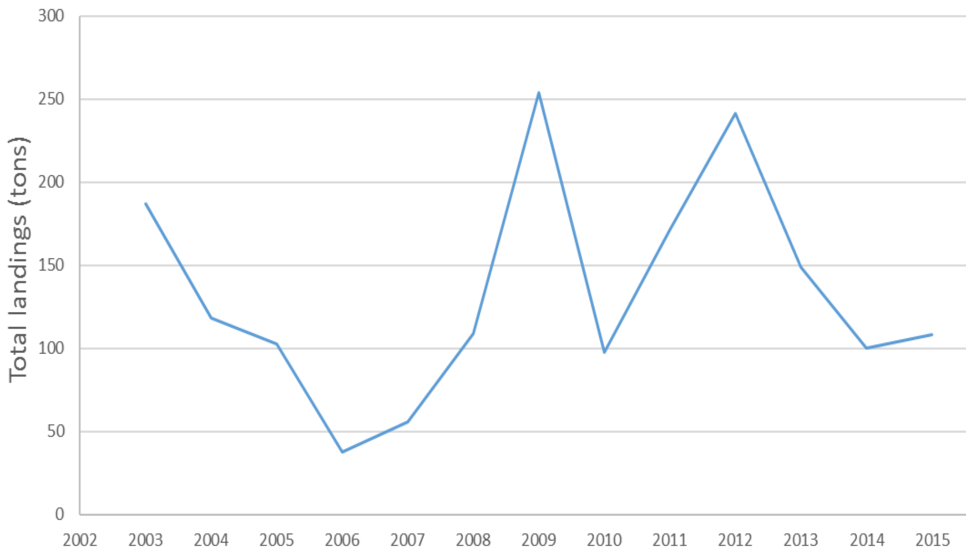


Figure 6.12.1.2.1. Annual landings of deep-water rose shrimp in GSA 1 (years 2003-2015).

The size structure of the landings, according to the DCF data, shows that the carapace length of the individuals landed ranged between 14 and 40 mm with a mean size ranging between 22 and 26 mm CL. According to the growth pattern of the species, fishing exploits mainly 1 and 2 age classes (Figure 6.12.1.2.2).

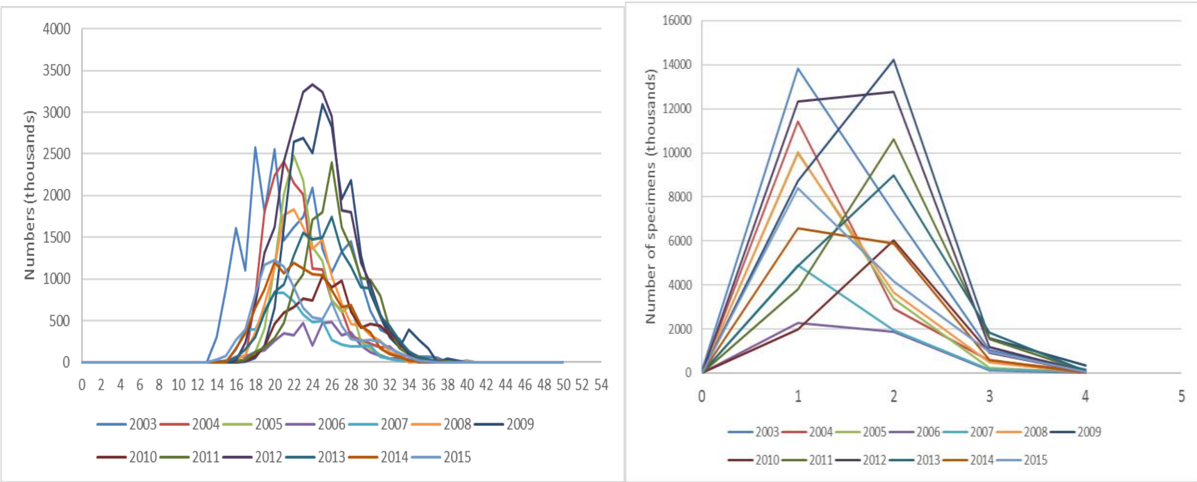


Figure 6.12.1.2.2. Deep-water rose shrimp in GSA 1. Size frequency distributions (left) and age structure (right) of the landings.

Discards

Discards of *P. longirostris* are very low (less than 2% in ally year except 2014 at 4%) and they were included in the total catch (Table 6.12.1.2.2).

Sum of products errors were less than 1% in total and less than 4% in any one year, they were ignored.

Table 6.12.1.2.2. Deep-water rose shrimp in GSA 1. Annual discard (t) for OTB in GSA 01 as provided through the official DCF (EU).

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Discard			1.7			0.6	1.7	1.8	0.4	1.7	0.9	4.3	1.2

6.12.1.3 Fishing effort data

The total fishing effort of the GSA 01 trawl fleet, expressed as kW*days at sea, has shown a progressive decrease in the period 2004-2015. It varied from about 6,396,000 in 2004 to 3,780,000 in 2015. Anyway, there is no information on the specific effort directed to *P. longirostris* in GSA 01.

Table 6.12.1.3.1. Deep-water rose shrimp in GSA 1. Fishing effort expressed in kW*days (thousands) (Source: DCF database).

2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
5915.5	6396.0	5939.6	5654.4	5427.3	4883.8	5095.9	5269.0	5079.0	4674.6	4371.6	3953.7	3780.3

Catches per unit of effort (CPUE) have been estimated by dividing the total catches for the fishing effort expressed in kW*fishing days (Figure 6.12.1.3.1)

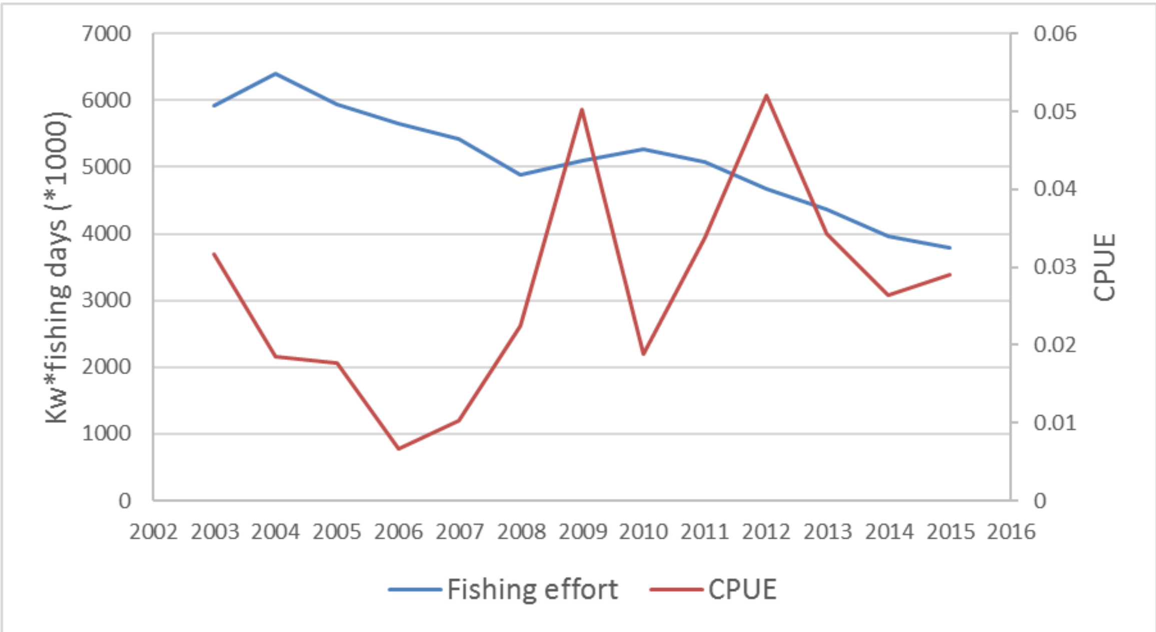


Figure 6.12.1.3.1. Deep-water rose shrimp in GSA 1. Fishing effort expressed in kW*days at sea and CPUE expressed as total catch (tons) divided by fishing effort.

6.12.1.4 Survey Indices of abundance and biomass by year and size/age

Since 1994 the MEDITS trawl survey has been regularly carried out in GSA 01, following the methodology adopted in the framework of the project.

Methods

According to the MEDITS protocol, trawl surveys were performed every year, during the spring-summer season, applying a random stratified sampling by depth (5 strata with depth limits at 50, 100, 200, 500 and 800 m), with haul maintained fixed throughout the time and allocated proportionally to the stratum area. The gear used was type GOC 73, with a 20 mm stretched mesh size in the cod-end; considering the small mesh size, a complete retention was assumed.
Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). The density and biomass indices of deep-water rose shrimp in

GSA01 were estimated on the depth strata 10-800 m and standardized to square km, using the swept area method.

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in the GSA:

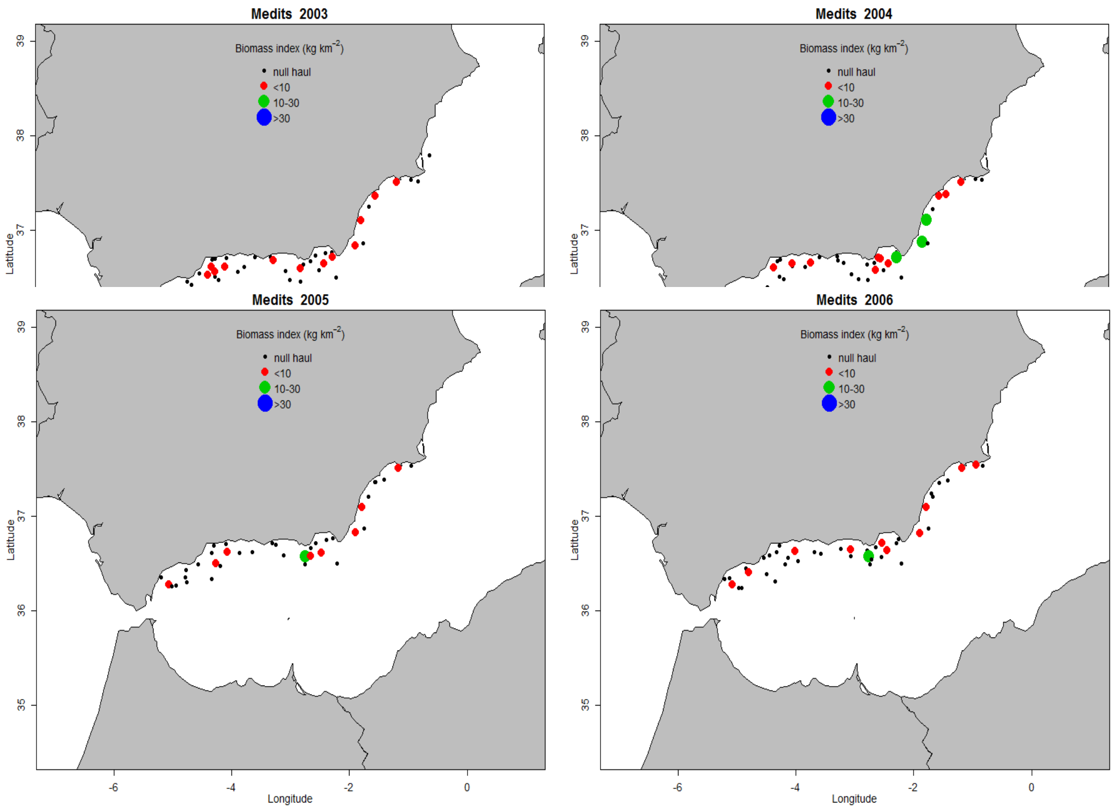
$$Yst = \Sigma\,(Yi*Ai) / A$$

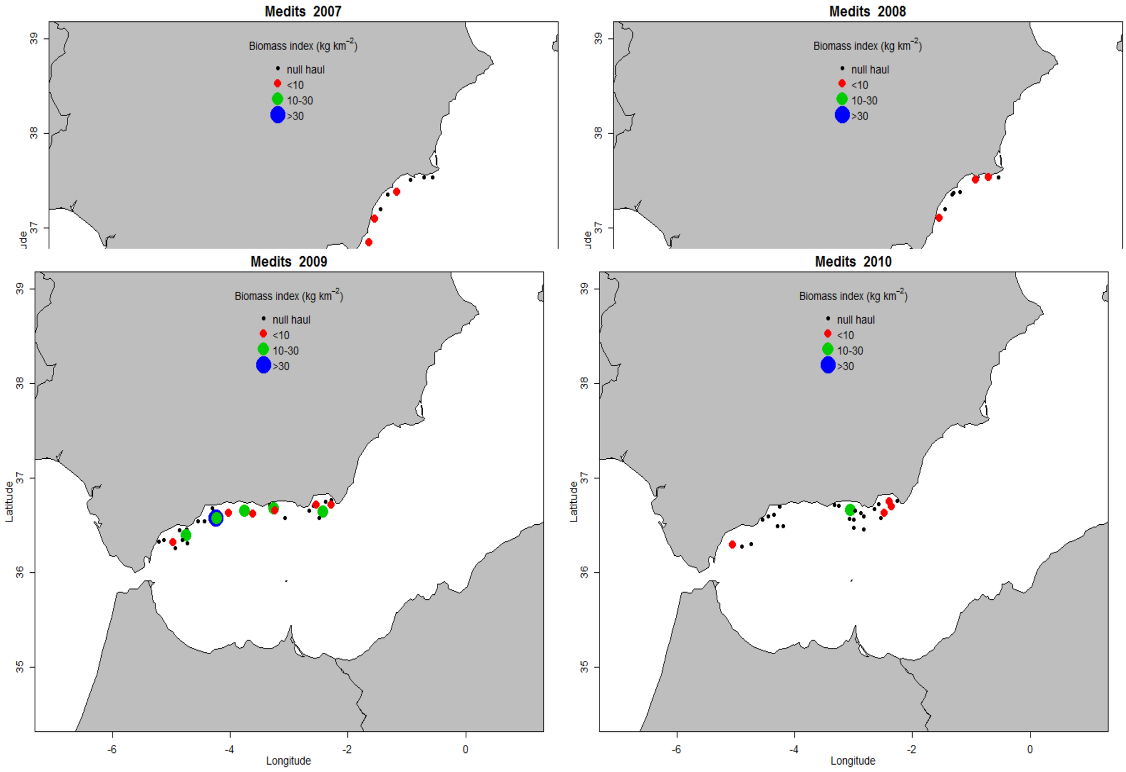
$$V(Yst) = \Sigma\,(Ai^2 * si^2 / ni) / A^2$$

Where:
A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as ± standard deviation.
It was noted that while this is a standard approach, the calculation may be biased due to a number of different factors including the change in the number of hauls over time, and change of the survey time over the years. Precision may also be affected by the choice of parametric distribution, a normal distribution is often assumed, whereas data may be better described by a delta-distribution, quasi-Poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O’Brien *et al.* 2004).
Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum.

Geographical distribution
P. longirostris shows a wide bathymetric distribution in GSA 01, being present from 50 to 650 m depth with greatest abundance between 150 and 400 m depth over muddy or sandy-muddy bottoms.





Medits 2007
Biomass index (kg km-2)
null haul
<10
10-30
>30
Medits 2008
Biomass index (kg km-2)
null haul
<10
10-30
>30
Medits 2009
Biomass index (kg km-2)
null haul
<10
10-30
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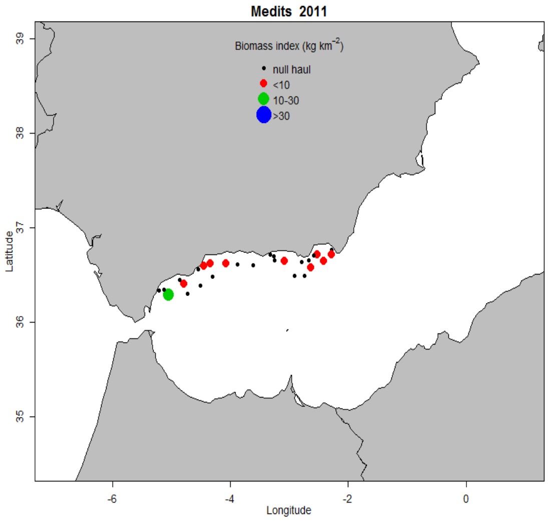
Latitude
Longitude
Medits 2010
Biomass index (kg km-2)
null haul
<10
10-30
>30
Latitude
Longitude


Medits 2011
Biomass index (kg km-2)
null haul
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10-30
>30
Latitude
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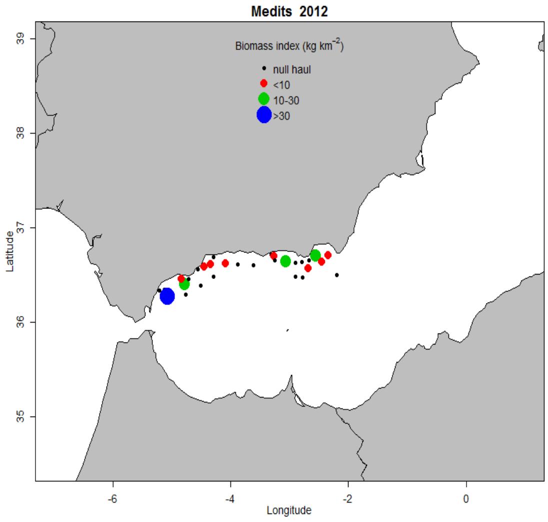
Medits 2012
Biomass index (kg km-2)
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<10
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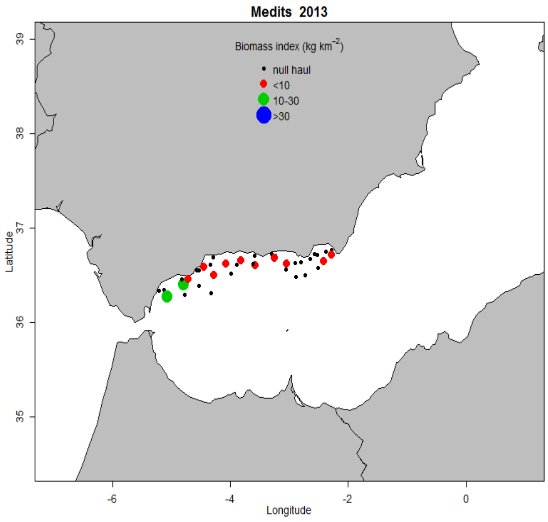
Medits 2013
Biomass index (kg km-2)
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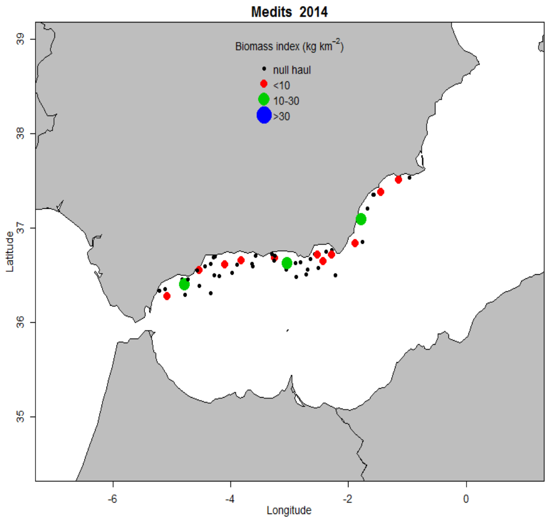
Medits 2014
Biomass index (kg km-2)
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10-30
>30
Latitude
Longitude

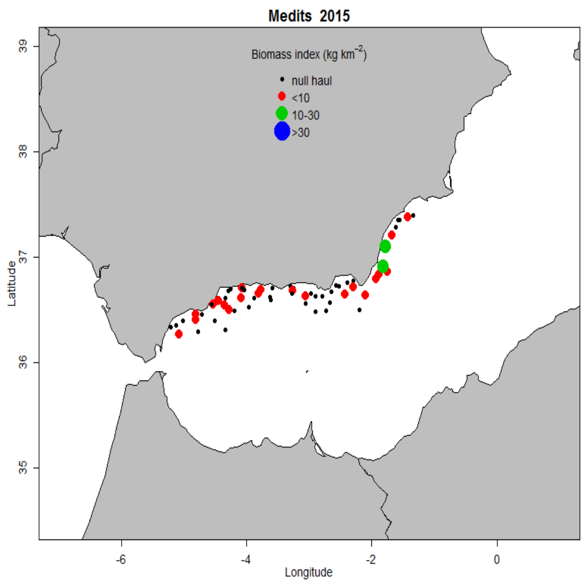


Figure 6.12.1.4.1. Deep-water rose shrimp in GSA 1. Distribution pattern in the period 2003-2015 (MEDITS survey).

Trends in abundance and biomass

The survey indices showed a fluctuating trend in density and biomass of deep-water rose shrimp, especially in the last 10 years, with two evident peaks in 2009 and 2012.

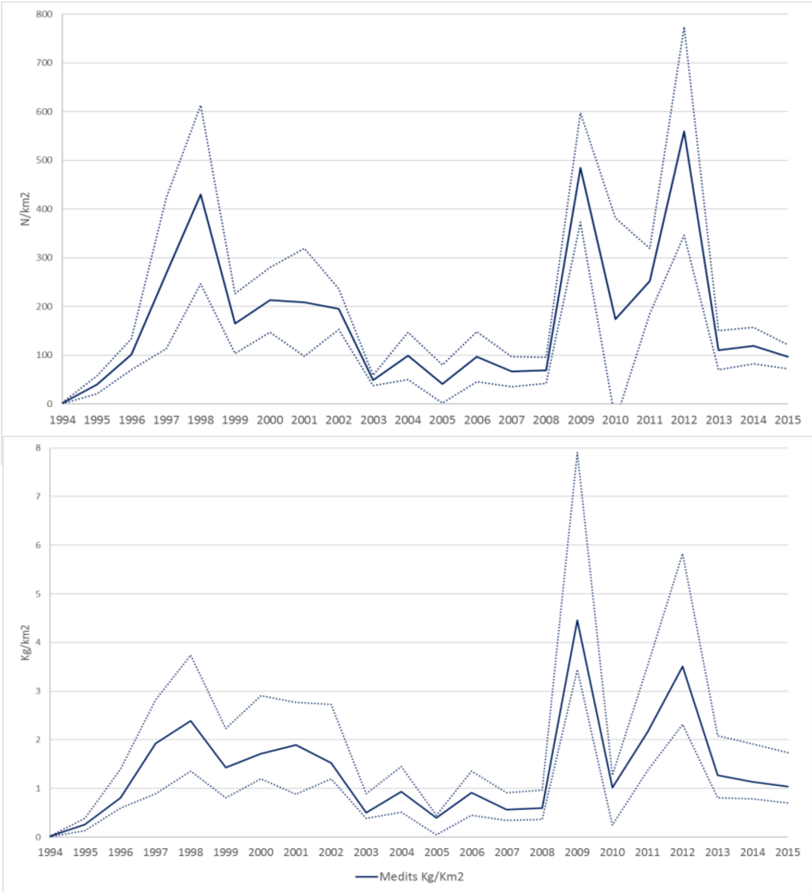
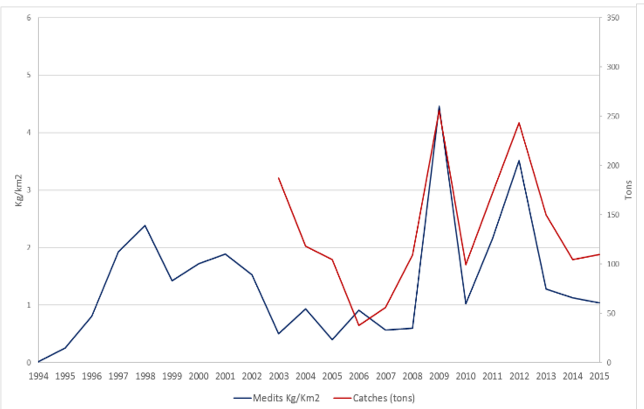


Figure 6.12.1.4.2. Deep-water rose shrimp in GSA 1. MEDITS standardized abundance and biomass indices (10-800 m).

The density and biomass indices from MEDITS survey generally follow the same trend as the total landing from commercial catches, especially from 2008 to 2015, as shown in Figure 6.12.1.4.3.



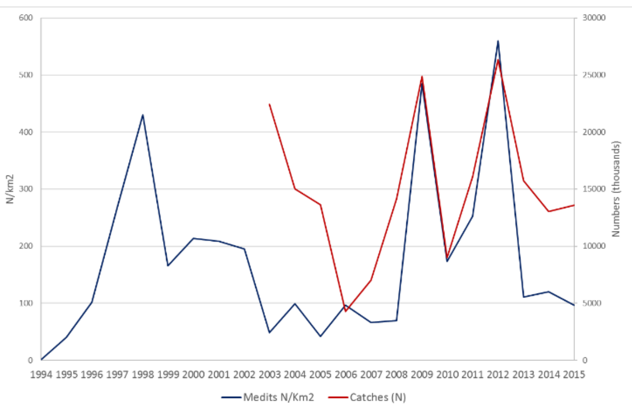


Figure 6.12.1.4.3. Deep-water rose shrimp in GSA 1. Commercial catches and survey indices trends.

Trends in abundance and biomass by length or age

Figure 6.12.1.4.4 display the stratified abundance indices by length of deep-water rose shrimp in GSA 01 collected during the MEDITS surveys from 1994 to 2015.

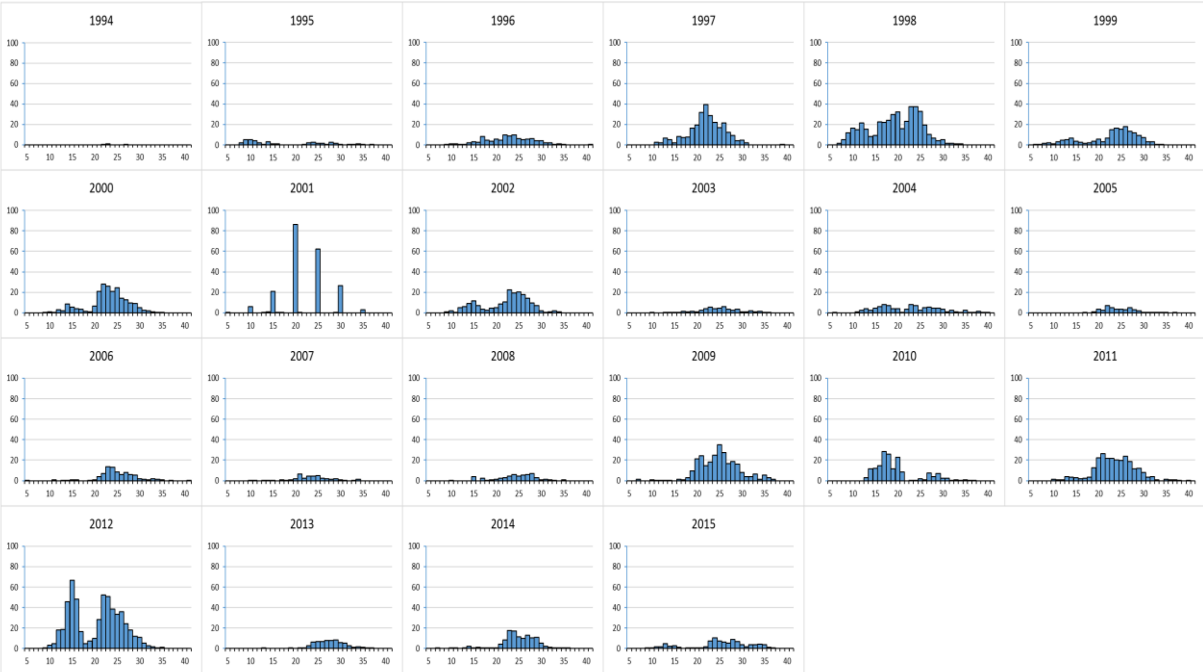


Figure 6.12.1.4.4. Deep-water rose shrimp in GSA 1. Stratified abundance indices by size, 1994-2015.

6.12.2 STOCK ASSESSMENT ON DEEP-WATER ROSE SHRIMP IN GSA 1

Method XSA

The deep-water rose shrimp stock assessment in GSA 01 was carried out by means of XSA method, using landing data collected under DCR-DCF from 2003 to 2015 and calibrated with surveys data (MEDITS 2003-2015). Discard was included in the analysis. The age range used was from 0 to 4+. FLR libraries were employed in order to perform the assessment.

Input parameters

Data from DCF provided at EWG 16-17 contained information on deep-water rose shrimp catches and the respective length structure for 2003-2015.

Biological parameters are listed in Table 6.12.2.1 and data used are reported in Table 6.12.2.2. A natural mortality vector computed using ProdBiom (Abella, 1997) was used. Length frequency distributions of commercial catches and surveys were transformed in age classes (up to the age class 4+) applying statistical slicing with the growth parameters reported. A sex-combined analysis was carried out. Given that the catches were composed mainly of individuals between 1 and 3 years, these ages were selected as the Fbar.

Table 6.12.2.1. Deep-water rose shrimp in GSA 1. Biological parameters.

	Growth parameters			Length-weight relationship	
	Linf	k	T0	a	b
Sex combined	45	0.3903	0.1019	0.003055	2.490608

Table 6.12.2.2. Deep-water rose shrimp in GSA 1. Input parameters for XSA.

Catch at age (Numbers, thousands)	0	1	2	3	4+
2003	145.0	13832.3	7294.6	1016.5	141.1
2004	0.0	11432.0	2912.8	568.8	86.7
2005	0.0	10028.0	3360.9	217.9	9.9
2006	2.2	2276.2	1856.4	128.3	26.1
2007	0.0	4897.8	1942.9	155.9	32.7
2008	1.5	9946.0	3674.6	487.8	10.5
2009	10.9	8712.6	14240.9	1593.4	333.2
2010	0.0	1966.5	6011.5	938.9	57.6
2011	0.0	3821.8	10616.4	1526.0	93.6
2012	0.0	12348.9	12780.7	1188.0	50.6
2013	0.0	4850.8	8964.8	1822.4	92.4
2014	0.0	6571.3	5866.7	600.1	11.8
2015	0.0	8409.4	4168.3	966.5	50.2

Mean weight at age (Catches)	0	1	2	3	4+
2003	0.002	0.006	0.011	0.018	0.025
2004	0.001	0.007	0.011	0.018	0.025
2005	0.001	0.007	0.011	0.019	0.024
2006	0.002	0.006	0.011	0.018	0.027
2007	0.001	0.006	0.011	0.018	0.029
2008	0.002	0.006	0.011	0.017	0.024
2009	0.002	0.007	0.011	0.019	0.024
2010	0.001	0.007	0.011	0.018	0.024
2011	0.001	0.007	0.011	0.018	0.024

2012	0.001	0.007	0.011	0.018	0.024
2013	0.001	0.006	0.010	0.016	0.023
2014	0.001	0.006	0.010	0.016	0.022
2015	0.001	0.006	0.011	0.017	0.023

Mean weight at age (Stock)	0	1	2	3	4+
2003	0.002	0.006	0.011	0.018	0.025
2004	0.001	0.007	0.011	0.018	0.025
2005	0.001	0.007	0.011	0.019	0.024
2006	0.002	0.006	0.011	0.018	0.027
2007	0.001	0.006	0.011	0.018	0.029
2008	0.002	0.006	0.011	0.017	0.024
2009	0.002	0.007	0.011	0.019	0.024
2010	0.001	0.007	0.011	0.018	0.024
2011	0.001	0.007	0.011	0.018	0.024
2012	0.001	0.007	0.011	0.018	0.024
2013	0.001	0.006	0.010	0.016	0.023
2014	0.001	0.006	0.010	0.016	0.022
2015	0.001	0.006	0.011	0.017	0.023

Proportion of mature	0	1	2	3	4+
2003	0	0.13	0.5	0.88	0.99
2004	0	0.13	0.5	0.88	0.99
2005	0	0.13	0.5	0.88	0.99
2006	0	0.13	0.5	0.88	0.99
2007	0	0.13	0.5	0.88	0.99
2008	0	0.13	0.5	0.88	0.99
2009	0	0.13	0.5	0.88	0.99
2010	0	0.13	0.5	0.88	0.99
2011	0	0.13	0.5	0.88	0.99
2012	0	0.13	0.5	0.88	0.99
2013	0	0.13	0.5	0.88	0.99
2014	0	0.13	0.5	0.88	0.99
2015	0	0.13	0.5	0.88	0.99

Natural mortality	0	1	2	3	4+
2003	1.72	0.97	0.82	0.76	0.72
2004	1.72	0.97	0.82	0.76	0.72
2005	1.72	0.97	0.82	0.76	0.72
2006	1.72	0.97	0.82	0.76	0.72
2007	1.72	0.97	0.82	0.76	0.72
2008	1.72	0.97	0.82	0.76	0.72

2009	1.72	0.97	0.82	0.76	0.72
2010	1.72	0.97	0.82	0.76	0.72
2011	1.72	0.97	0.82	0.76	0.72
2012	1.72	0.97	0.82	0.76	0.72
2013	1.72	0.97	0.82	0.76	0.72
2014	1.72	0.97	0.82	0.76	0.72
2015	1.72	0.97	0.82	0.76	0.72

Tuning MEDITS data	0	1	2	3	4+
2003	0.75	18.97	23.36	4.89	0.43
2004	9.21	49.57	29.73	6.37	3.76
2005	0.00	20.46	18.48	1.87	0.59
2006	1.77	32.16	44.31	5.79	0.99
2007	1.57	19.37	15.78	1.96	0.00
2008	0.32	20.02	29.89	2.80	0.48
2009	3.47	102.62	137.43	18.34	6.77
2010	9.04	129.72	23.84	4.83	1.56
2011	8.88	125.14	106.76	8.71	2.63
2012	70.04	320.23	158.76	11.09	0.50
2013	0.29	6.40	48.27	11.39	2.06
2014	2.13	41.41	71.19	4.41	0.66
2015	10.51	21.75	44.87	15.52	3.49

Results

A sensitivity analysis with different fse values (0.5, 1.0, 1.5, 2.0, 2.5 and 3.0) was performed. As showed by Figure 6.12.2.1, the different settings produced similar estimates of recruitment, SSB and F trends, except for the one with shrinkage 0.5 that was different from the others.

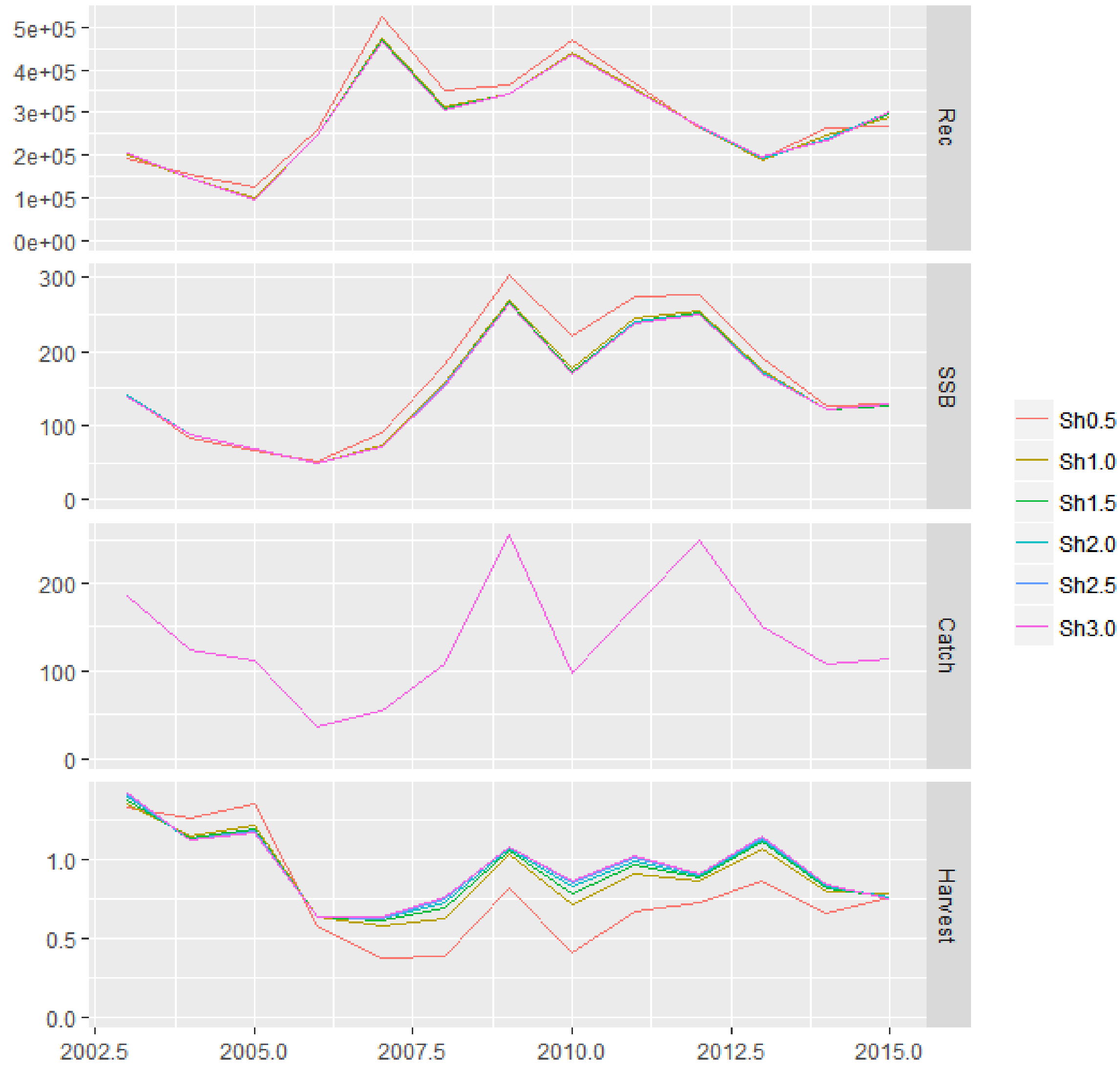


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Figure 6.12.2.1. Deep-water rose shrimp in GSA 1. XSA outputs for different shrinkage scenarios. On the basis of the residuals distribution and of the retrospective analysis, the model with rage = 0, qage= 2.0 and fse= 1.0 was adopted as final model (Table 6.12.2.3).

Table 6.12.2.3. Inputs selected to run the final XSA.

fse	rage	qage	shk.n	shk.f	shk.yrs	shk.ages
1.0	0.0	2.0	TRUE	TRUE	3.0	2.0

Residuals from tuning fleets (MEDITS) per age and year were relatively low, ranging from 3 to - 3, and did not show any trend with time (Figure 6.12.2.2).

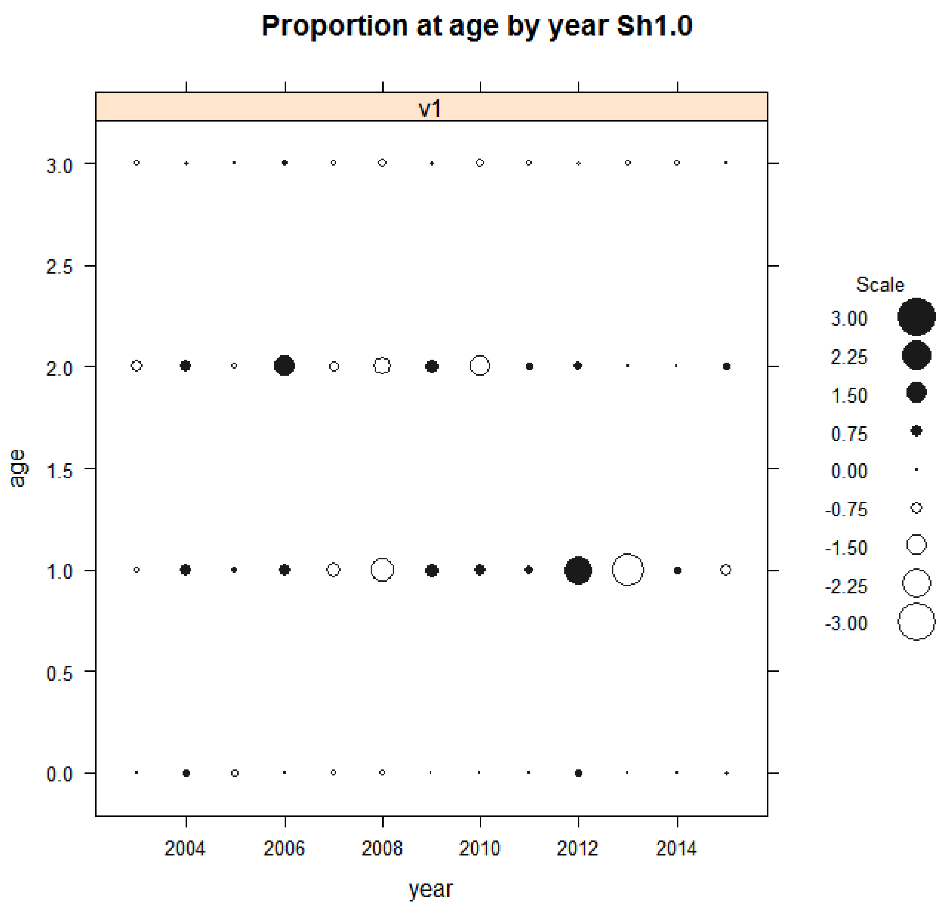


Figure 6.12.2.2. Deep-water rose shrimp in GSA 1. Residuals at age obtained with shrinkage set at 1.0.

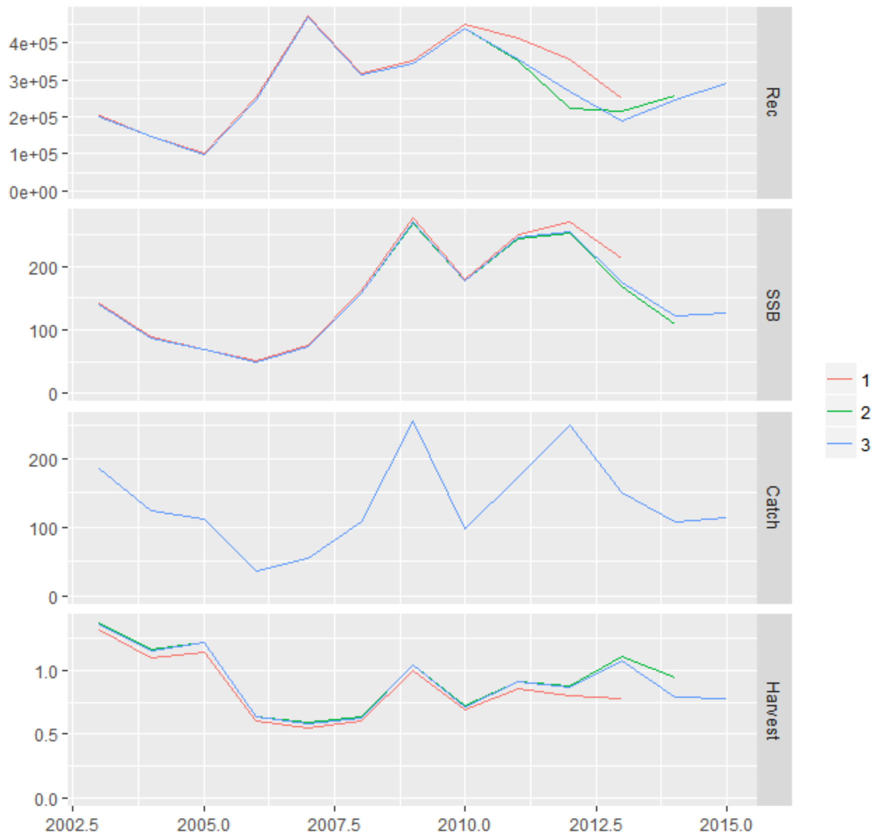


Figure 6.12.2.3. Deep-water rose shrimp in GSA 1. Retrospective analysis with shrinkage set at 1.0.

The retrospective analysis conducted on recruitment, mean F and SSB indicates good agreement between years in the assessment results, with no systematic bias (Figure 6.12.2.3).

XSA main outputs (Figure 6.12.2.4) showed a fluctuating trend in the catches, recruitment and SSB. In the case of recruitment, a decrease was observed from 2010 to 2013 followed by an increase in the last two years. Recruitment varied from a minimum of 99 million in 2005 to 472 million in 2007. The highest values of SSB and catches were observed in 2009 (SSB 269 tons). Fishing mortality is characterized by a decreasing trend in the first part of the time series (2003-2008) and then the trend is quite stable. The F_{curr} value in 2015 is 0.78. The total biomass of the stock ranged between 396 tons in 2005 and 1581 tons in 2009. XSA summary results are reported in Table 6.12.2.5.

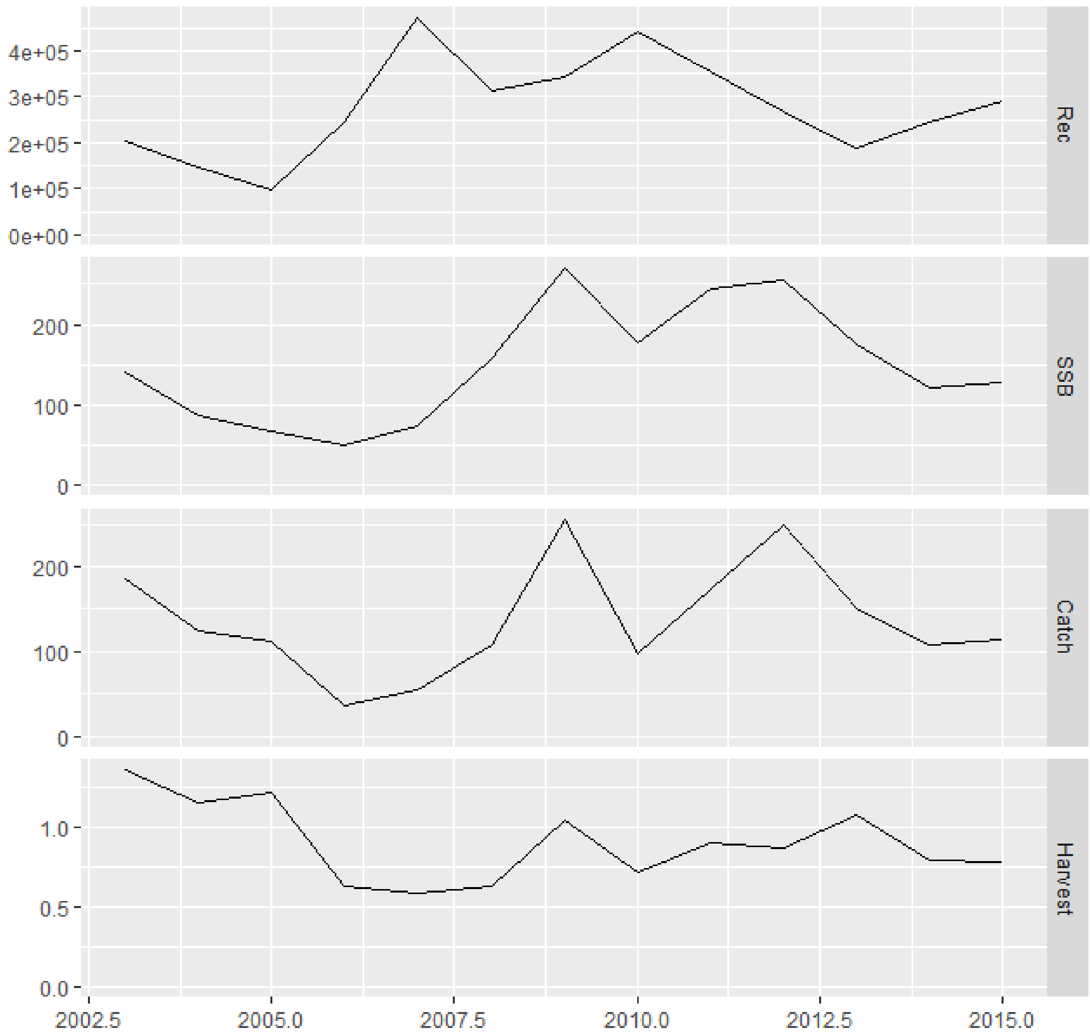


Figure 6.12.2.4. Deep-water rose shrimp in GSA 1. XSA main outputs.

Table 6.12.2.4 Deep-water rose shrimp in GSA 1. Stock numbers-at-age (thousands) as estimated by XSA.

Age	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
0	193875	156035	125024	258725	523774	349711	363749	469066	369466	262939	193047	264195	268742
1	36652	34655	27941	22387	46328	93790	62621	65131	83994	66159	47084	34568	47308
2	13609	5359	6079	4403	7070	14514	29366	18332	23431	29426	17434	14829	9036
3	1981	1146	424	444	704	1819	3944	3466	4072	3261	4461	1720	2629
4+	247	158	17	85	141	37	763	201	232	129	209	32	127

Table 6.12.2.5 Deep-water rose shrimp in GSA 1. XSA summary results. SSB and catch are in tons, recruitment in thousands of individuals.

	Recruitment (thousands)	SSB (t)	Catch (t)	Fbar(1-3)
2003	201743	140.75	185.3	1.35
2004	146997	87.23	124.6	1.15
2005	98905	68.14	111.4	1.21
2006	246648	49.07	37.1	0.63
2007	472093	72.98	54.5	0.58
2008	313978	157.57	108.8	0.63
2009	345243	269.16	255.7	1.04
2010	441228	177.24	98.4	0.71
2011	355542	244.88	172.9	0.90
2012	267280	254.27	249.3	0.87
2013	189744	174.63	150.0	1.07
2014	245659	121.00	108.0	0.79
2015	290243	127.12	113.9	0.78

Table 6.12.2.6 Deep-water rose shrimp in GSA 1. XSA summary results: F-at-age matrix.

	F at age				
	0	1	2	3	4+
2003	0.00	0.94	1.58	1.54	1.54
2004	0.00	0.72	1.66	1.07	1.07
2005	0.00	0.97	1.46	1.21	1.21
2006	0.00	0.23	1.34	0.32	0.32
2007	0.00	0.20	0.80	0.74	0.74
2008	0.00	0.21	0.52	1.15	1.15
2009	0.00	0.29	1.77	1.05	1.05
2010	0.00	0.05	0.84	1.24	1.24
2011	0.00	0.08	1.28	1.35	1.35

2012	0.00	0.38	1.20	1.02	1.02
2013	0.00	0.18	1.71	1.32	1.32
2014	0.00	0.38	0.88	1.11	1.11
2015	0.00	0.37	1.25	0.72	0.72

Method 2. Length-based analysis

Length-based methods were used for deriving some indicators explored in WKLIFE IV. (ICES, 2015). They allow classifying the stocks according to conservation/sustainability, yield optimization and MSY considerations. Analysis required data on the stock catch/landings–length composition and life-history parameters as Linf.

The length-based indicators analysis was performed using the commercial landings in 2009 to 2015 (discards considered negligible) and the following life-history parameters: Linf=45 mm.

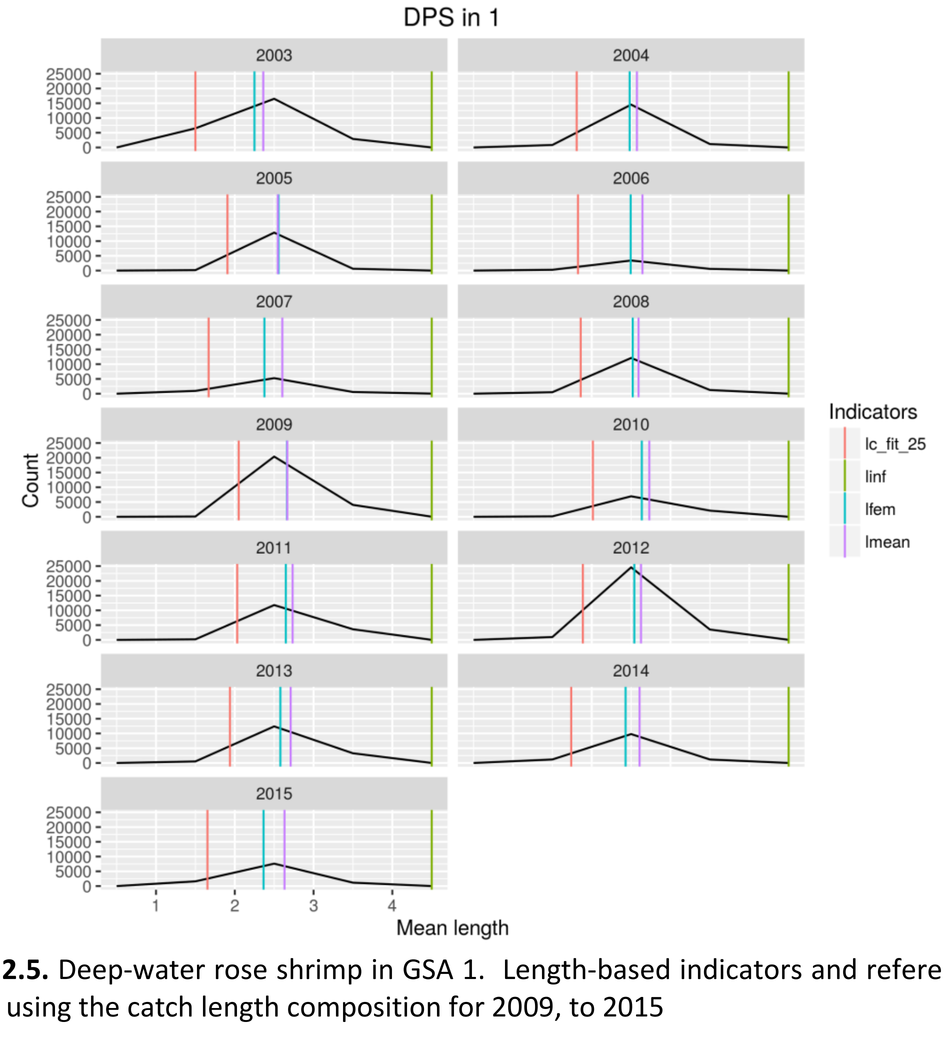


Figure 6.12.2.5. Deep-water rose shrimp in GSA 1. Length-based indicators and reference points for rose shrimp using the catch length composition for 2009, to 2015

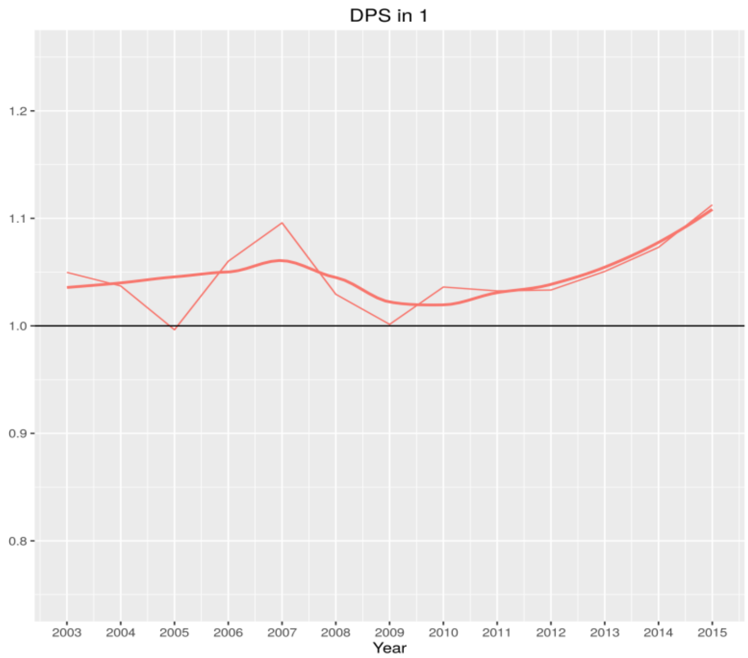


Figure 6.12.2.6 Deep-water rose shrimp in GSA 1. Length-based indicator for rose shrimp using the catch length composition for 2009 to 2015

The overall perception from length-based indicators is that the stock is being fished slightly below MSY level. Such a perception supports the results obtained from XSA assessments. The indicator also supports the view of decreasing F over time.

6.12.3 REFERENCE POINT

The time series of SSB and R values is not sufficient to allow evaluation of S-R elements of MSY, so the WG has applied the STECF recommended method of F0.1. The yield per recruit analysis was run using FLBRP library. The analysis was performed to estimate $F_{0.1}$ as target equilibrium YPR reference point for the stock. In Figure 6.12.2.5 $F_{0.1}$ and F_{bar} are compared. $F_{0.1}$ estimated by the model was 0.87.

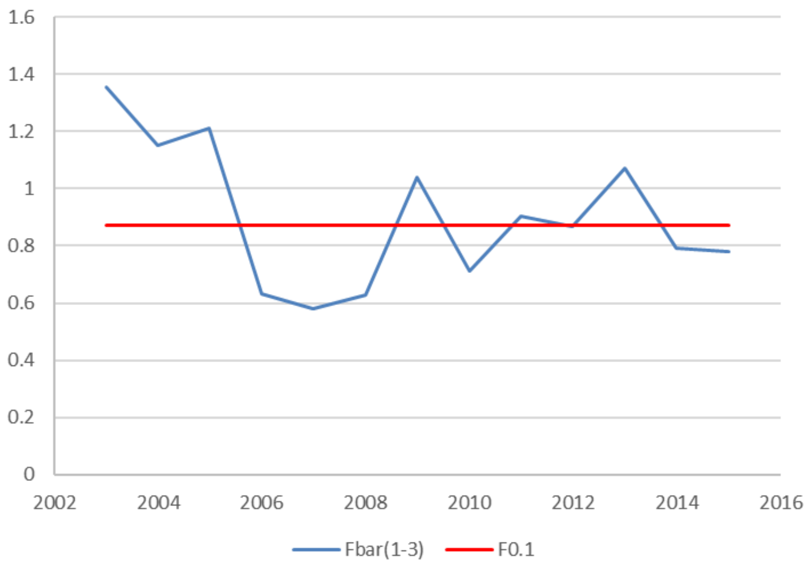


Figure 6.12.2.5. Deep-water rose shrimp in GSA 01. Trend of F_{bar} obtained by means of XSA and comparison with $F_{0.1}$.

According to the F estimates obtained using landing and discard data with XSA, F_{curr} was fluctuating up and below the estimated reference value of $F_{0.1}$=0.87. STECF-EWG 16-17 considers the stock has been harvested sustainably (fully exploited) consistent with high long term yield and lower risk of stock collapse. It is important to consider that this stock could be strongly driven by environmental and ecological factors (e.g. water temperature, predatory release effect) that can make difficult to evaluate the effect of fishing on the stock. EWG 16-17 advises to not increase the current level of effort of the relevant fleets, in order to avoid future loss in stock productivity.

6.12.4 SHORT TERM FORECAST

A deterministic short term prediction for the period 2016 to 2018 was performed using the FLR routines and based on the results of the XSA stock assessment.

The input parameters for the deterministic short-term predictions for the period 2016 to 2018 were the same used for the XSA stock assessment and its results. An average of the last three years has been used for weight at age, maturity at age and F at age.

Recruitment (age 0) has been estimated from the population results as the geometric mean of the last 3 years (241882 thousand individuals).

Table 6.12.2.7 Deep-water rose shrimp in GSA 1. Short term forecast in different F scenarios. Average (2013-15) weight at age, maturity at age and F at age. Recruitment (age 0) geomean (2013-15) (241882 thousand individuals).

Rationale	Ffactor	Fbar	Catch 2016	Catch 2017	Catch 2018	SSB 2017	SSB 2018	Change SSB 2017-2018(%)	Change Catch 2015-2017(%)
Zero catch	0	0	132.99	0	0	135.12	226.22	67.43	-100
High long term yield (F0.1)	0.997	0.87	132.99	137.94	126.66	135.12	127.00	-6.01	21.10
Status quo	1	0.87	132.99	138.23	126.81	135.12	126.82	-6.14	21.36
Different Scenarios	0.1	0.87	132.99	19.28	25.73	135.12	211.04	56.19	-83.07
	0.2	0.17	132.99	37.00	46.90	135.12	197.40	46.09	-67.51
	0.3	0.26	132.99	53.31	64.34	135.12	185.13	37.01	-53.19
	0.4	0.35	132.99	68.36	78.76	135.12	174.09	28.84	-39.99
	0.5	0.44	132.99	82.26	90.72	135.12	164.12	21.47	-27.78
	0.6	0.52	132.99	95.14	100.67	135.12	155.13	14.81	-16.47
	0.7	0.61	132.99	107.09	108.98	135.12	146.99	8.78	-5.98
	0.8	0.70	132.99	118.21	115.95	135.12	139.61	3.32	3.78
	0.9	0.78	132.99	128.56	121.82	135.12	132.91	-1.63	12.87
	1.1	0.96	132.99	147.28	131.06	135.12	121.27	-10.25	29.30
	1.2	1.05	132.99	155.76	134.71	135.12	116.20	-14.00	36.75

	1.3	1.13	132.99	163.73	137.87	135.12	111.57	-17.43	43.74
	1.4	1.22	132.99	171.23	140.63	135.12	107.32	-20.57	50.33
	1.5	1.31	132.99	178.30	143.05	135.12	103.42	-23.46	56.53
	1.6	1.39	132.99	184.98	145.19	135.12	99.83	-26.12	62.40
	1.7	1.48	132.99	191.30	147.11	135.12	96.51	-28.57	67.94
	1.8	1.57	132.99	197.29	148.84	135.12	93.45	-30.84	73.20
	1.9	1.65	132.99	202.98	150.41	135.12	90.61	-32.94	78.20
	2	1.74	132.99	208.39	151.85	135.12	87.98	-34.89	82.95

6.12.5 QUALITY AND PROPOSALS FOR FUTURE ASSESSMENTS

Data from EU DCF as submitted through the official data call in 2016 were used. Length-frequencies distributions (LFD) were missing for the "métier" OTB_DWS. Missing LFDs were borrowed from other OTB segments. Catches age structure was also missing in the database.
Biological parameters (growth parameters, sex-ratio) were not furnished for this species in GSA 01.

6.13 DEEP-WATER ROSE SHRIMP IN GSA 9

6.13.1 DATA GATHERING OF DEEP-WATER ROSE SHRIMP IN GSA 9

6.13.1.1 Stock Identity and Biology

GSA 9 includes the Ligurian Sea (northern part of the GSA) and the northern Tyrrhenian Sea (southern part). The GSA 9 may not correspond to a single stock unit. According to the results of Stockmed project, deep-water rose shrimp of GSA 9 is part of the stock that includes many GSAs of western Mediterranean (GSA 1, GSAs 5-8, GSA 11). However, the analyses underlined that the southern part of GSA 9 presents characteristics more similar to those of GSA 10.

In the present assessment, the stock was assumed to be confined within the GSA 9 boundaries (Figure 6.13.1.1).

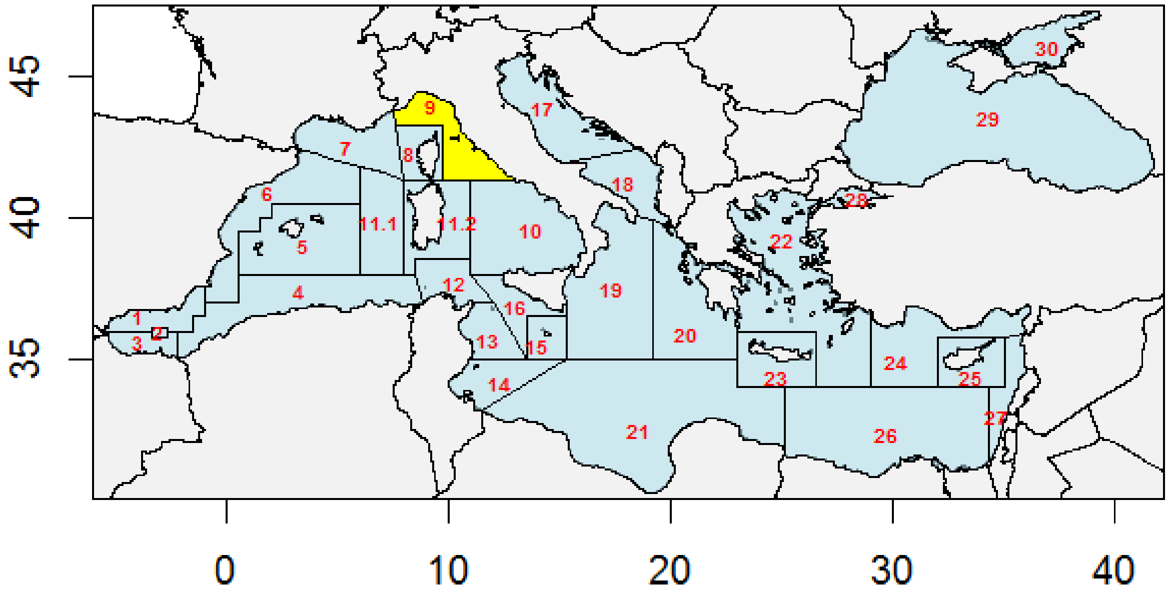


Figure 6.13.1.1. Geographical location of GSA 9.

The species shows a wide bathymetric distribution in GSA 9, being present from 50 to 650 m depth with greatest abundance between 150 and 400 m depth over muddy or sandy-muddy bottoms (Ardizzone and Corsi, 1997; Biagi *et al*., 2002).
The highest abundances have been found in the Tyrrhenian part of the GSA (south Tuscany and Latium).
Recruits (CL 15 mm) occur all year round, with a main peak from July to October (De Ranieri *et al*., 1997). The main nurseries revealed a high spatio-temporal persistency (Figure. 6.13.1.2) between 60 and 220 m depth.
The core of nursery areas overlap with crinoid beds (*Leptometra phalangium*) areas over the shelf-break (Colloca *et al*., 2004, 2006a; Reale *et al.*, 2005). This is a peculiar habitat in the GSA 09, which is also an essential fish habitat for other commercially important species as the European hake, *Merluccius merluccius*. A positive size-depth distribution was found with an increased abundance of larger females with depth (Ardizzone *et al*., 1990).

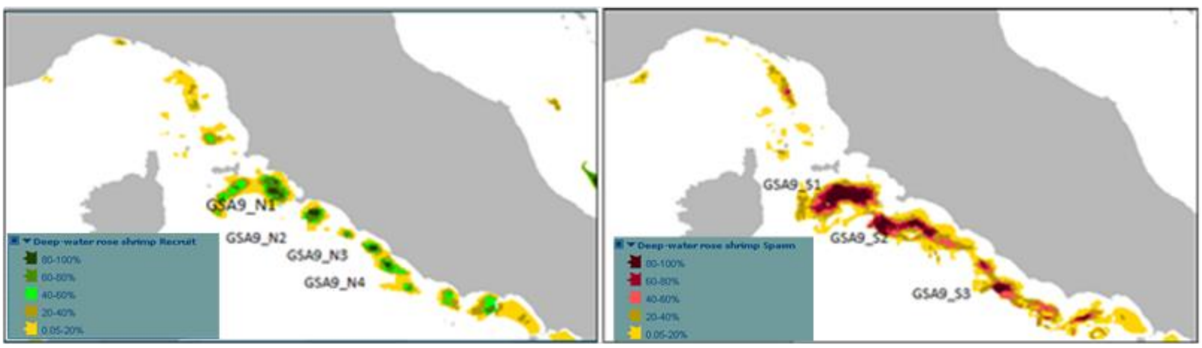


Figure 6.13.1.2. Deep-water rose shrimp in GSA 9. Temporal persistence of deep-water rose shrimp (left) and adults distribution (right) calculated from MEDITS time-series density maps (1994-2012). The Figure is taken from the MEDISEH project.

6.13.1.1 Growth

The growth of *P. longirostris* has been studied in the southern part of the GSA 9 (central Tyrrhenian Sea) using modal progression analysis (Ardizzone *et al.*, 1990). The following sets of Von Bertalanffy growth parameters were estimated: Females: L∞ = 43.5, K=0.74, t_0=-0.13; Males: L∞ = 33.1, K=0.93, t_0=-0.05. The life cycle is of 3-4 years. Females grow faster than males attaining larger size-at-age.

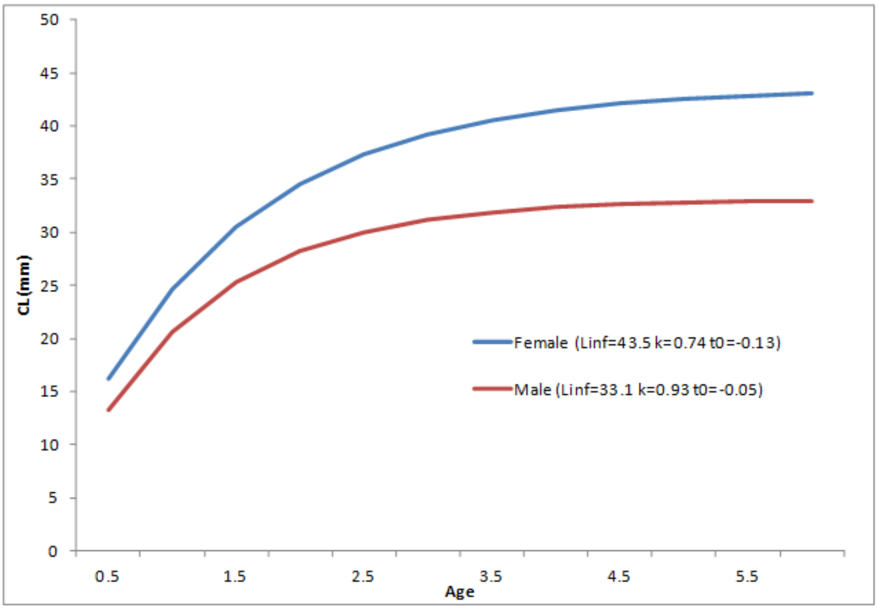


Figure 6.13.1.3. Deep-water rose shrimp in GSA 9. Von Bertalanffy curves used in the analysis.

6.13.1.2. Maturity

In the northern Tyrrhenian Sea, the reproduction area of *P. longirostris* is located from 150 to 350 m; mature females are present all year round, even though the species shows two peaks in reproductive activity, one in spring and another at the beginning of autumn (Mori *et al.*, 2000a). In the central Tyrrhenian Sea, the southern part of GSA 9, a main winter spawning was hypothesized (Ardizzone *et al.*, 1990). The size at onset of sexual maturity estimated for different years in northern Tyrrhenian Sea is about 24 mm CL (Mori *et al.*, 2000a).

The number of oocytes in the ovary was related to the size of the females and ranged from 23,000 oocytes at 26 mm CL to 204,000 at 43 mm CL. An exponential relationship was observed between fecundity and carapace length: Fecundity = $0.0569 \cdot CL^{4.0177}$ (r = 0.829) (Mori *et al.*, 2000a).

6.13.1.3 Ecology

P. longirostris diet is composed of a great variety of organisms; the prey items consisted mostly of external skeletons of bottom organisms, always crushed and often in an advanced state of deterioration. Crustaceans dominated the diet both qualitatively and quantitatively; they were characterized by a high abundance of peracarids, mainly represented by mysids (*Lophogaster typicus*) and amphipods (Lysianassidae). Molluscs (juvenile bivalves and gastropods), cephalopods (Sepiolids), small echinoderms, annelids, small fishes, foraminiferans, (Globigerinidae) and organic detritus are other important food item in the diet of the species (Mori *et al.*, 2000b).

6.13.1.4 Natural mortality

Natural mortality was estimated using ProdBiom (Abella *et al*., 1998). A curve by sex has been estimated, and then a single M vector was produced combining the two vectors obtained by sex (weighed average by age class). The input parameters used were $L\infty$ = 43.5, K=0.74, t0=-0.13 for females and $L\infty$ = 33.1, K=0.93, t0=-0.05 for males. The natural mortality vector by age is reported in Table 6.13.1.4.1.

Table 6.13.1.4.1. Deep-water rose shrimp in GSA 9. Vector of natural mortality by age.

Age	M
0	1.45
1	0.60
2	0.43
3+	0.35

6.13.1.2 Catch data

General description of the fisheries

In GSA 9 the deep-water rose shrimp is one of the most important target species of the fishery carried out on the shelf break and upper part of continental slope. The species is exclusively exploited with otter bottom trawling.

The main fishing grounds are located in the southern part of the GSA 9, to the south of Elba Island (northern and central Tyrrhenian Seas); they are mainly exploited by several trawlers of Porto Santo Stefano, Porto Ercole, Fiumicino, Terracina and Gaeta. *P. longirostris* belongs to a fishing assemblage distributed from 150 to 350 m depth, where the main target species are European hake, *Merluccius merluccius*, Horned octopus, *Eledone cirrhosa* and Norway lobster, *Nephrops norvegicus*, at greater depths (Biagi *et al*., 2002; Colloca *et al*., 2003; Sartor *et al*., 2003; Sbrana *et al*., 2006). In the last years the species has become an important component of the bottom trawl landing also in the northern part of the GSA.

The majority of bottom trawlers of GSA 9 operate daily fishing trips with some vessels (especially those of Porto Santo Stefano) staying out for two-three days and mainly in the summer. The mean number of fishing days/year per vessel carried out by the GSA 9 trawlers varied from 187 in 2004 to 177 in 2006. Due to the distance of the fishing grounds to the main harbours, fishing activity targeting *P. longirostris* shows some seasonal variations, with maxima from mid-spring to mid-autumn.

Landings

The annual total landing of deep-water rose shrimp observed from 2002 to 2015 is reported in Figure 6.13.1.2.1. Total landing shows an increasing trend along the analyzed period. The minimum value was observed in 2002 (161 tons), while the maximum one in the last year (792 tons). The landings were mainly taken by demersal otter trawlers. A small amount was registered for other gears, but they disappeared from the statistics since 2009.

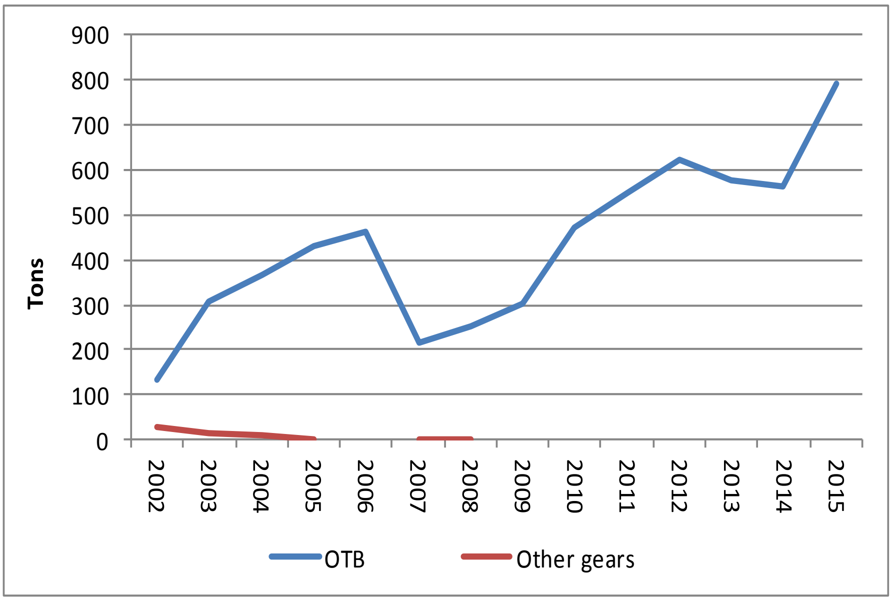


Figure 6.13.1.2.1 Deep-water rose shrimp in GSA 9. Landings from 2002 to 2015.

Table 6.13.1.2.1 Deep-water rose shrimp in GSA 9. Annual landings (t) by fishing technique as provided through the official DCF.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
OTB	133	308	367	430	462	215	253	303	473	551	621	576	561	792
Other gears	28	15	9	1		2	1							
Total	161	323	376	431	462	217	254	303	473	551	621	576	561	792

The size structure of the landings, according to the DCR-DCF data, shows that the most exploited sizes ranged from 18 to 35 mm CL (Figure 6.13.1.2.2); specimens under the
Minimum Conservation Size (20 mm CL) represent, on average, 12% of the number of individuals annually landed. According to the growth pattern of the species, fishing exploits mainly 1 and 2 age classes.

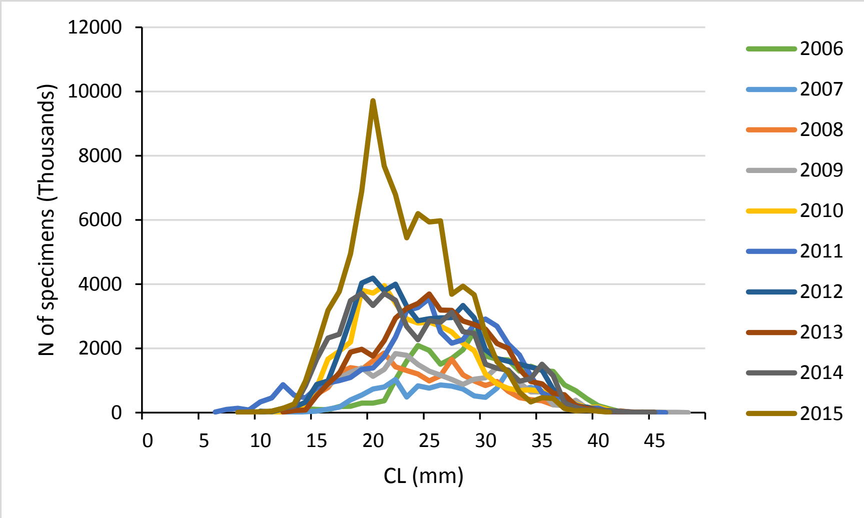


Figure 6.13.1.2.2. Deep-water rose shrimp in GSA 9. Size frequency distributions of the landing.

Discards

Discards of *P. longirostris* are generally low. They mainly occur on the fishing grounds located at depths of less than 200 m, where juvenile specimens are more abundant. In the period considered (2006-2015), discard represented about 9% of the annual total catch. The discarded biomass *of P. Longirostris* ranged from a minimum of 8 tons in 2012 to a maximum of 89 tons in 2015 (Table 6.13.2.2.1), typically less than 1% of catch.

Table 6.13.1.2.3 Deep-water rose shrimp in GSA 9. Annual discard (t) for OTB in GSA 09 as provided through the official DCF (EU).

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
OTB	34	35	41	49	27	63	8	30	45	89

The size structure of discard, according to the DCR-DCF data, is reported in Figure 6.13.1.2.3. The most abundant sizes ranged between 10 and 20 mm CL, corresponding to specimens of 0 age class.

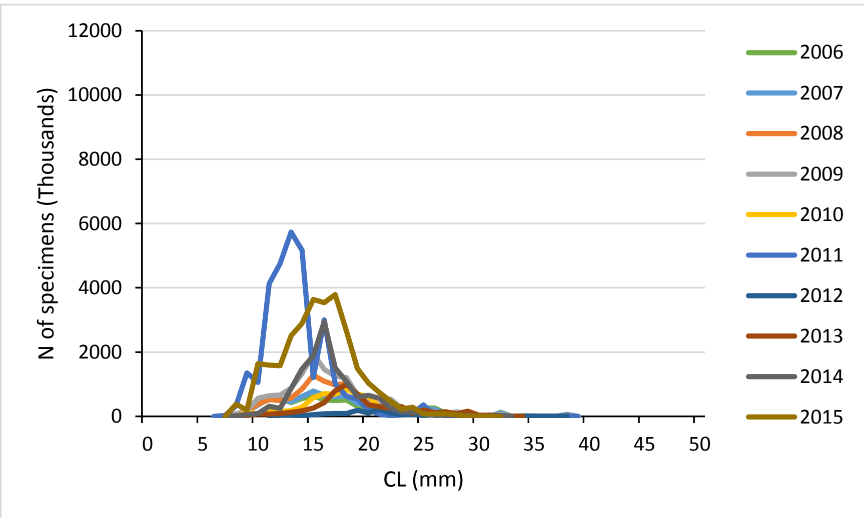


Figure 6.13.1.2.3 Deep-water rose shrimp in GSA 9. Size frequency distributions of the discard.

6.13.1.3 Fishing effort data

The total fishing effort of the GSA 09 trawl fleet, expressed as kW*days at sea, has shown a progressive decrease in the period 2004-2012. It varied from about 14,800,000 in 2004 to 10,000,000 in 2012. In the last three years a slightly increase was observed. Anyway, there is no information on the specific effort directed to *P. longirostris* in GSA 09.

Table 6.13.1.3.1 Deep-water rose shrimp in GSA 9. Fishing effort expressed in kW*days (thousands) (Source: DCF database).

2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
14583.6	14671.0	14820.3	14700.6	12404.8	12782.1	10775.9	12172.8	11228.0	10696.2	9997.9	10724.9	10975.7	11095.3

Catches per unit of effort (CPUE) have been estimated by dividing the total catches for the fishing effort expressed in kW*fishing days (Figure 6.13.1.3.1.). Although fishing effort shows a decreasing trend in the period considered, CPUEs steadily increase reaching the maximum value in 2015.

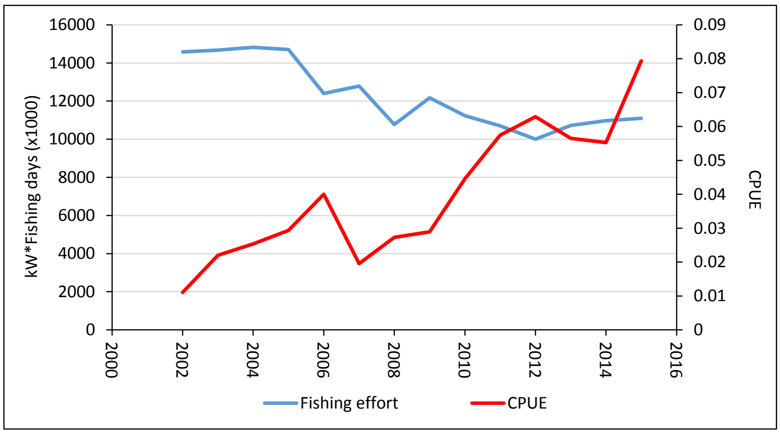


Figure 6.13.1.3.1. Deep-water rose shrimp in GSA 9. Fishing effort expressed in kW*days at sea and CPUE expressed as total catch (tons) divided by fishing effort.

6.13.1.4 Survey Indices of abundance and biomass by year and size/age

6.13.1.4.1 Survey #1 (MEDITS)

Since 1994 MEDITS trawl surveys has been regularly carried out each year during the spring season.

6.13.1.4.1.1 Survey Methods

Based on the DCF data, abundance and biomass indices were recalculated. In GSA 9 the following number of hauls was reported per depth stratum (Table 6.13.1.4.1).

Table 6.13.1.4.1. Number of hauls per year and depth stratum in GSA 9, 1994-2015.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
10-50	21	20	20	20	21	20	20	20	15	15	15	16	15	15	16	16	15	15	15	16	15	14
50-100	21	21	20	22	20	21	22	22	17	17	17	16	18	18	16	16	19	18	17	17	19	19
100-200	38	39	40	38	39	39	38	38	30	30	30	31	29	29	31	31	29	30	31	30	29	30
200-500	40	40	40	41	40	41	42	42	33	31	34	34	35	35	34	34	34	33	35	35	36	35
500-800	33	33	33	32	33	32	31	31	25	27	24	23	23	23	23	23	23	24	22	22	21	22
Total	153	153	153	153	153	153	153	153	120	120	120	120	120	120	120	120	120	120	120	120	120	120

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. Hauls noted as valid were used only, including stations with no catches of hake, red mullet or rose shrimp (zero catches are included).

The abundance and biomass indices by GSA were calculated through stratified means. This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$Yst = \Sigma (Yi*Ai) / A$

$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$

Where:

A=total survey area

Ai=area of the i-th stratum

si=standard deviation of the i-th stratum

ni=number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Yi=mean of the i-th stratum

Yst=stratified mean abundance

V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± t(student distribution) * V(Yst) / n

It was noted that while this is a standard approach, the calculation may be biased due to a number of different factors including the change in the number of hauls over time, and change of the survey time over the years. Precision may also be affected by the choice of parametric distribution, a normal distribution is often assumed, whereas data may be better described by a delta-distribution, quasi-Poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien *et al.* 2004).

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance*100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA.

6.13.1.4.1.2 Geographical distribution

P. longirostris shows a wide bathymetric distribution in GSA 9, being present from 50 to 650 m depth with greatest abundance between 150 and 400 m depth over muddy or sandy-muddy bottoms.

In the first part of the time series, the highest abundances have been found in the southern part of the GSA (Tyrrhenian Sea). In the last years, the species has become more abundant and has also become important in the northern part of the GSA (Ligurian Sea).

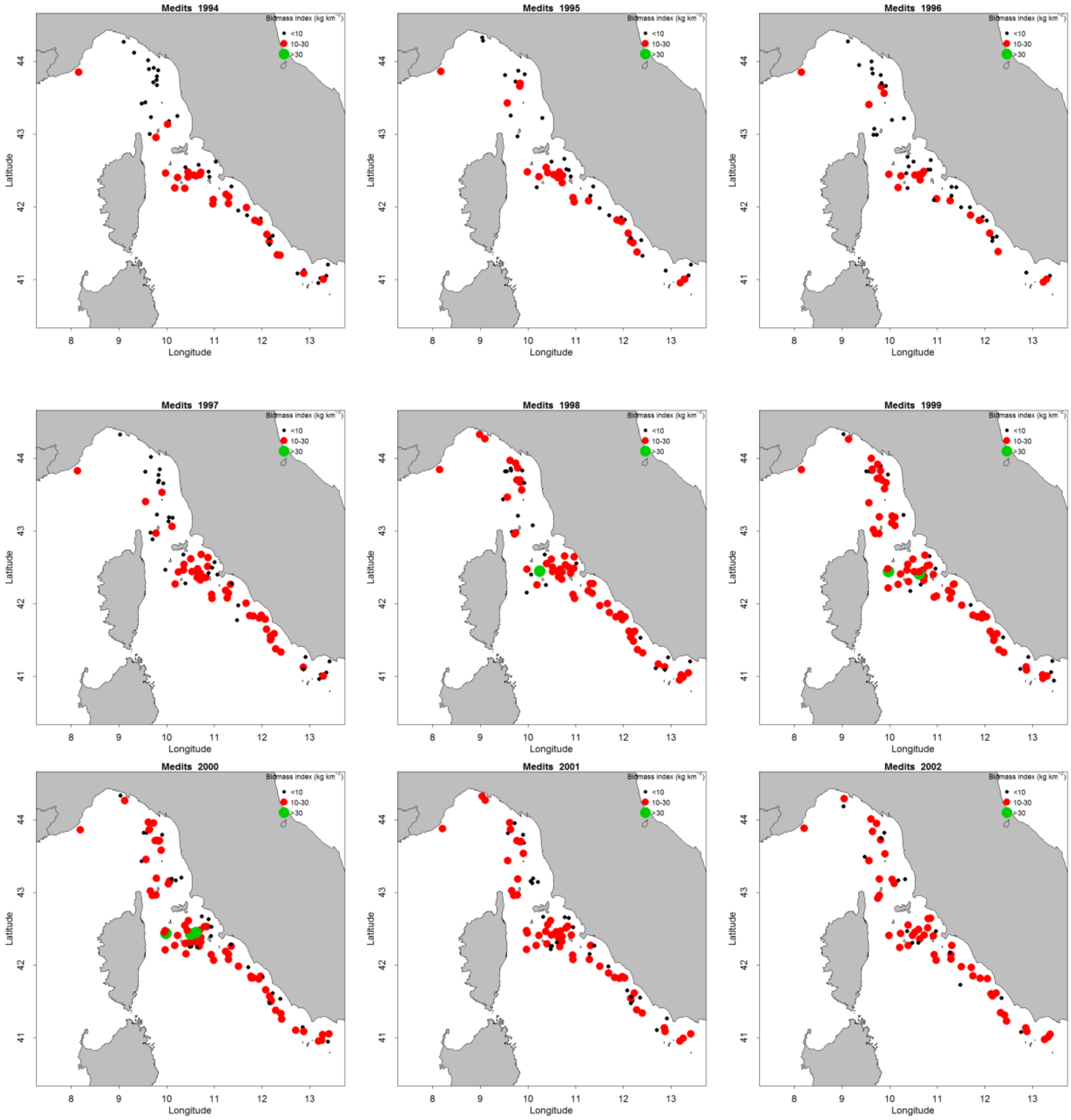
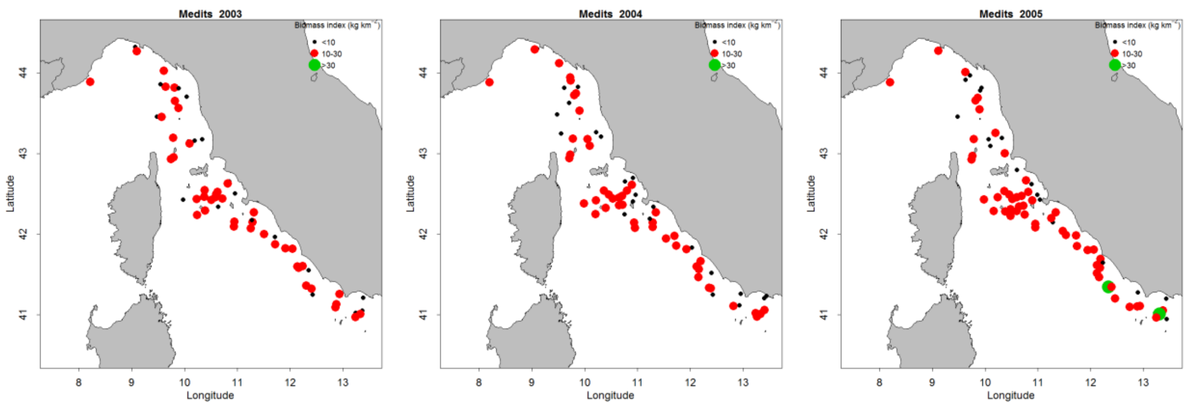


Figure 6.13.1.4.1. Deep-water rose shrimp in GSA 9. Distribution pattern in the period 1994-2002 (MEDITS survey).



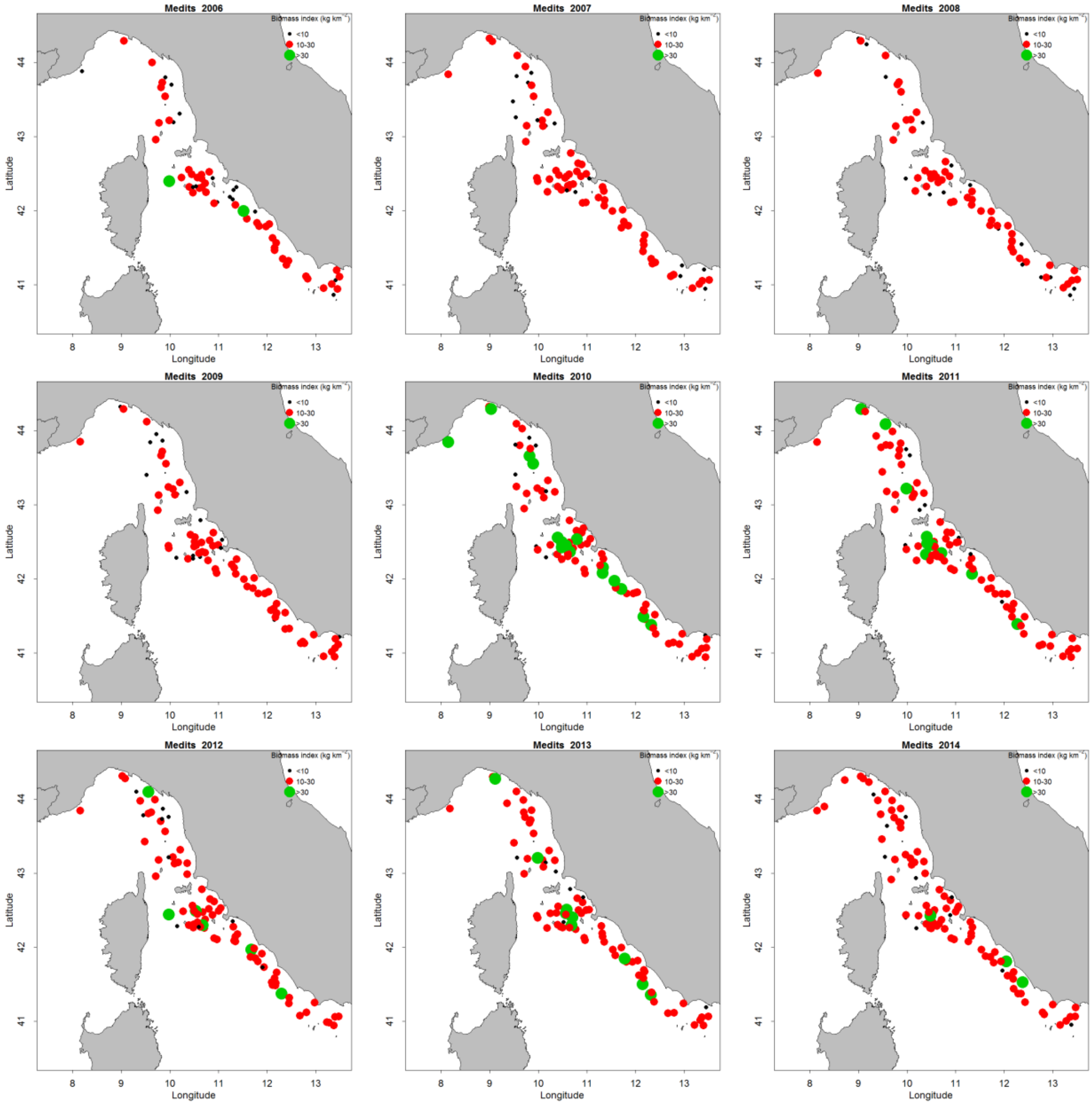


Figure 6.13.1.4.2 Deep-water rose shrimp in GSA 9. Distribution pattern in the period 2003-2014 (MEDITS survey).

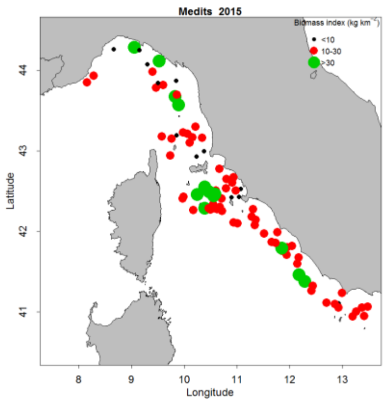


Figure 6.13.1.4.3 Deep-water rose shrimp in GSA 9. Distribution pattern in 2015 (MEDITS survey).

Trends in abundance and biomass

Since 1994, MEDITS trawl survey was regularly carried out each year. The survey showed a temporal increasing trend in density and biomass of deep-water rose shrimp, with maximum value in 2010. After that, an opposite trend was detected and the abundance decreased until 2014. In 2015, a very high value was observed. The increasing trend in abundance could be related to the warming trend in water temperature. *P. longirostris* is a thermopile species that could benefit by the ongoing climatic change in the Mediterranean region. However, the relationship between environmental variability and deep-water rose shrimp population dynamic has not been investigated yet.

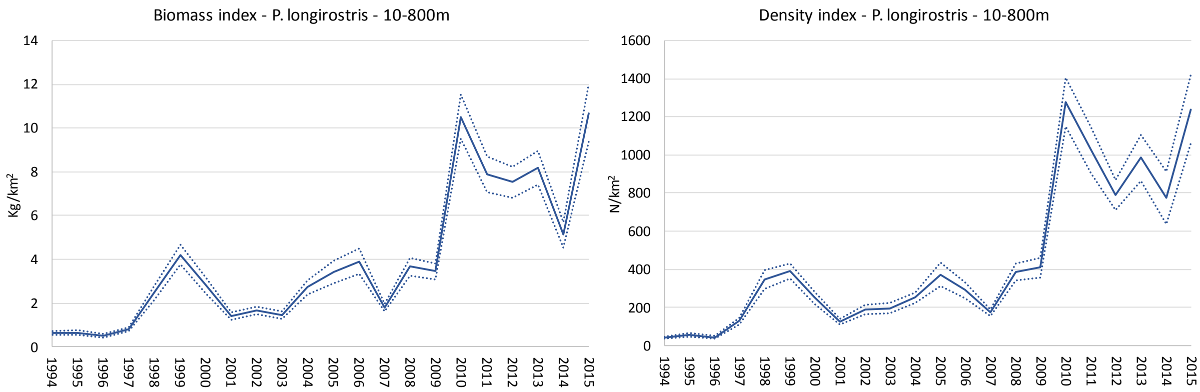


Figure 6.13.1.4.4. Deep-water rose shrimp in GSA 9. MEDITS standardized abundance and biomass indices (10-800 m).

Trends in abundance and biomass by length or age

Figs 6.13.1.4.5-7 display the stratified abundance indices by length of GSA 9 collected during the MEDITS surveys from 1994 to 2015.

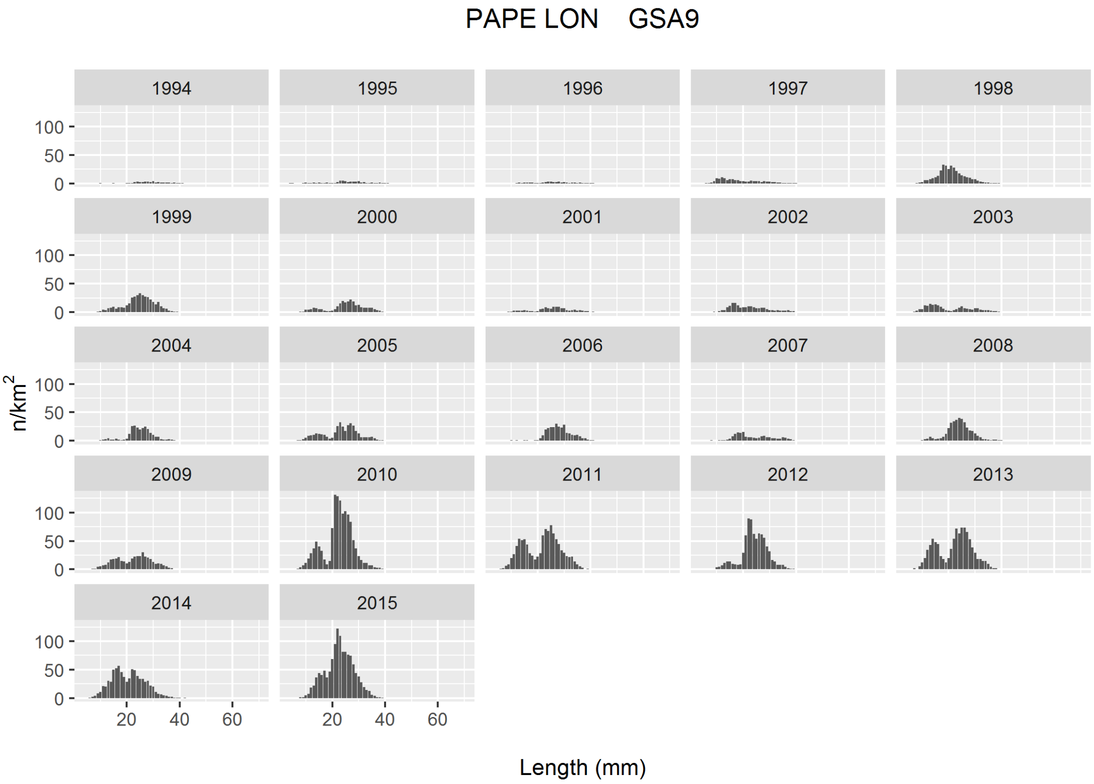


Figure 6.13.1.4.5. Deep-water rose shrimp in GSA 9. Stratified abundance indices by size for the total population, 1994-2015.

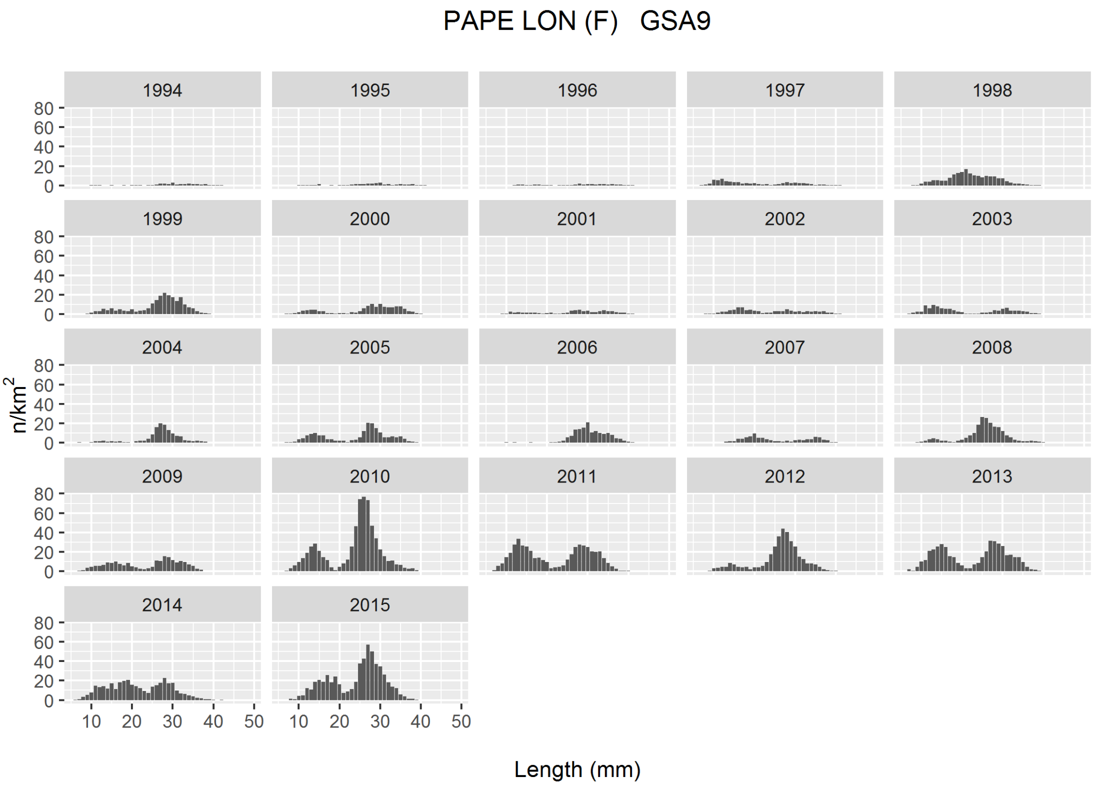


Figure 6.13.1.4.6. Deep-water rose shrimp in GSA 9. Stratified abundance indices by size for females, 1994-2015.

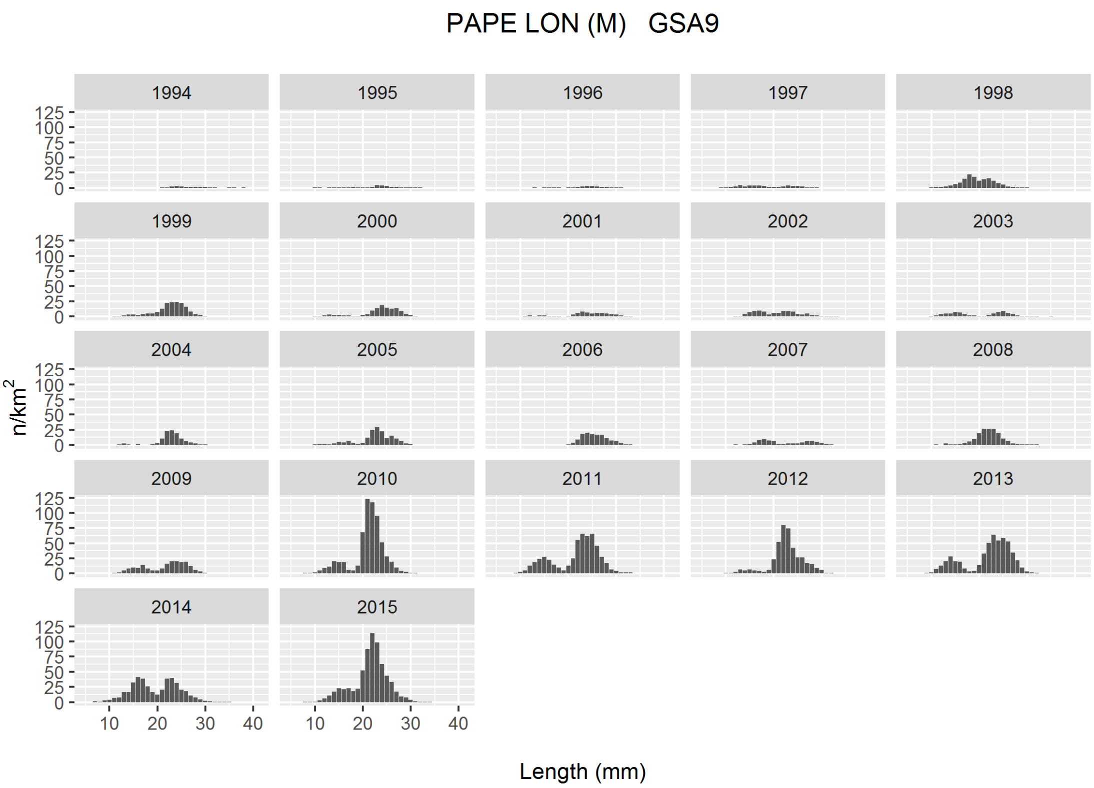


Figure 6.13.1.4.7. Deep-water rose shrimp in GSA 9. Stratified abundance indices by size for males, 1994-2015.

The boxplots of the MEDITS length frequencies distributions (LFDs) for the total population and by sex are shown in Figs. 6.13.1.4.8, 9 & 10. Some evident fluctuations in the LFD are observed before 2004 due to the high presence of recruits in the years 1997-1998 and 2002-2003. In the last years, the demographic structure of the populations resulted more stable.

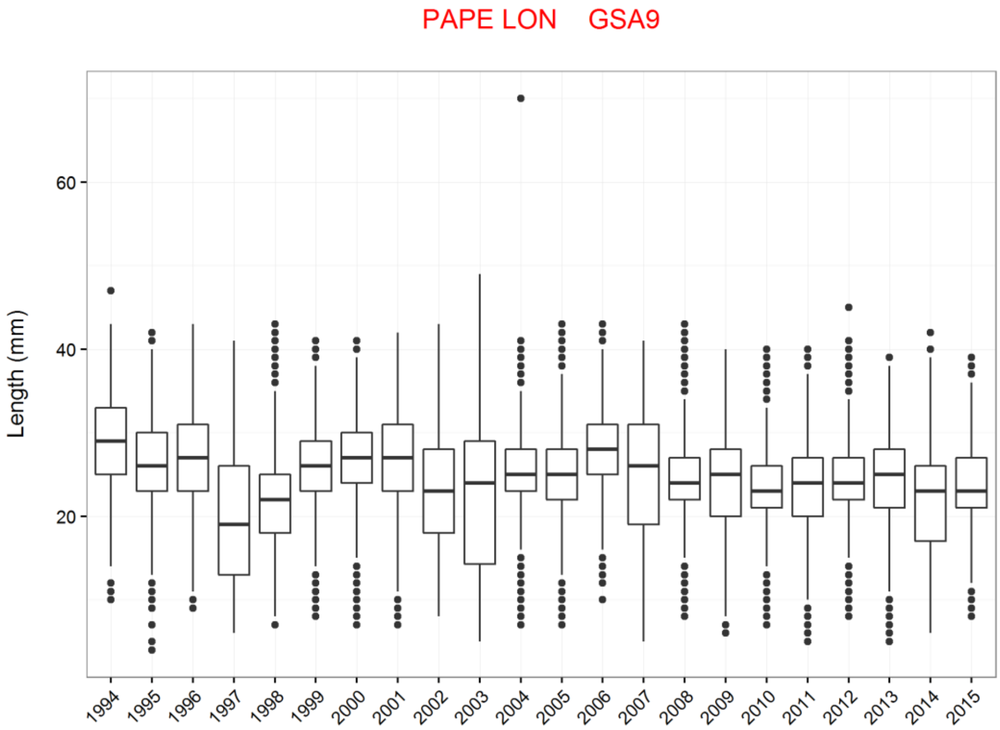


Figure 6.13.1.4.8. Deep-water rose shrimp in GSA 9. Boxplot of the length frequency distributions of the population obtained in the MEDITS surveys.

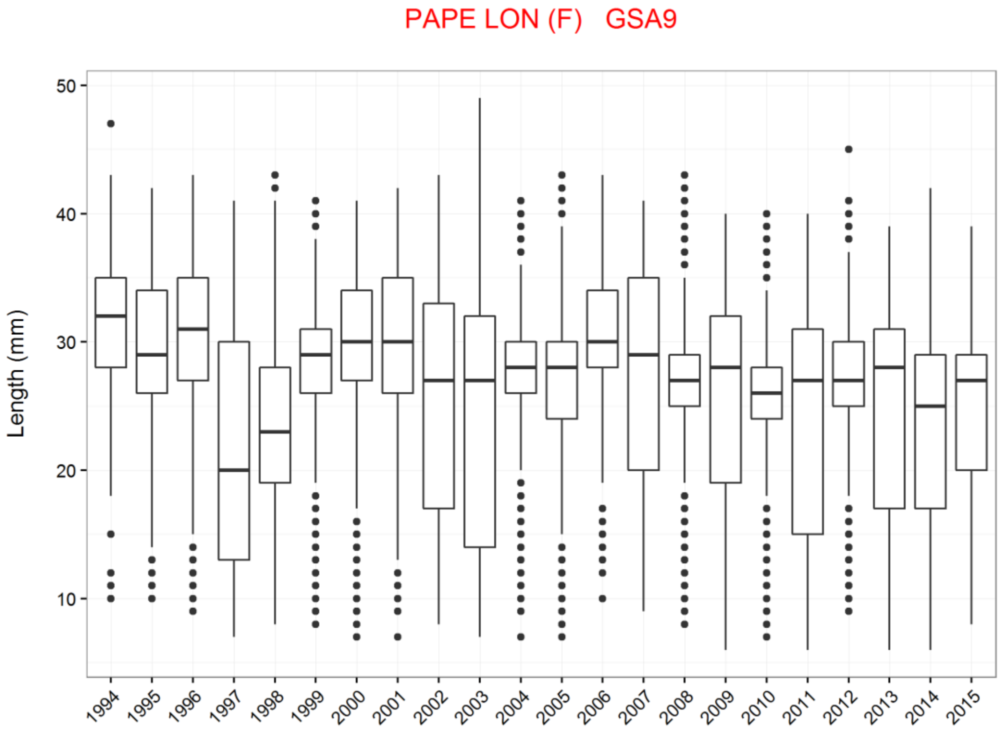


Figure 6.13.1.4.9 Deep-water rose shrimp in GSA 9. Boxplot of the length frequency distributions of females obtained in the MEDITS surveys.

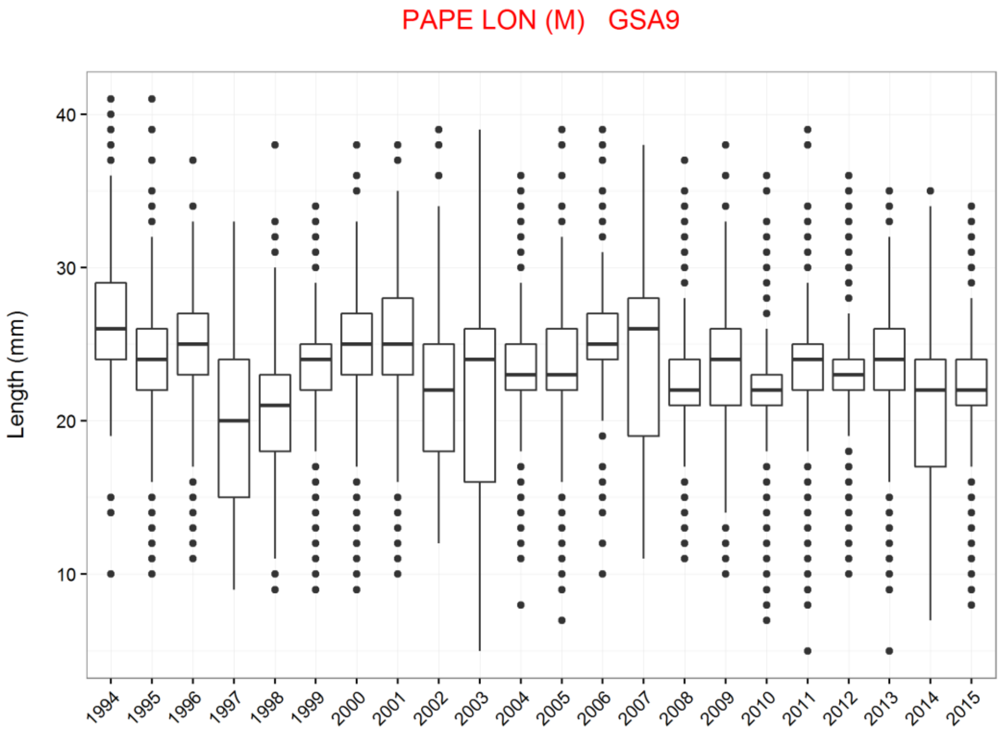


Figure 6.13.1.4.10. Deep-water rose shrimp in GSA 9. Boxplot of the length frequency distributions of males obtained in the MEDITS surveys.

6.13.2 STOCK ASSESSMENT ON DEEP-WATER ROSE SHRIMP IN GSA 9

The following assessment was carried out at the FAO-GFCM Working Group on Stock Assessment of Demersal Species (WGSAD) carried out at Rome (Italy) from 7 to 12 November 2016. The assessment was evaluated at the EWG16-17, and fully endorsed by the group, the report of the results is provided here for STECF as the report from the WGSAD is not available and is not expected to be published before the 1st STECF plenary in 2017. The numerical aspects of the assessment are the same as those from WGSAD, though there may be minor editorial differences in the text.

Methods: XSA

An XSA assessment was carried out during EWG 16-17 using catch data collected under DCR-DCF from 2006 to 2015 and calibrated with surveys data (MEDITS 2006-2015). FLR libraries were employed in order to perform the analyses.

Input parameters

Data from DCF provided at EWG 16-17 contained information on deep-water rose shrimp catches and the respective age structure for 2006-2015. Plus group was set at age 3.

Biological parameters are listed in Table 6.13.2.1 and data used are reported in Table 6.13.2.2. A natural mortality vector computed using ProdBiom (Abella, 1998) was used. Length frequency distributions of commercial catches and surveys were split by sex and then transformed in age classes (up to the age class 3+) applying Statistical slicing with different growth parameters. XSA analysis was performed by sex combined. Given that the catches were composed mainly of individuals between 0 and 2 years, these ages were selected as the Fbar.

Sum of Products errors were less than 1% and ignored.

Table 6.13.2.1 Deep-water rose shrimp in GSA 9. Biological parameters.

	Growth parameters			Length-weight relationship	
Sex	L_{inf}	k	t_0	a	b
Male	33.1	0.93	-0.05	0.0044	2.359
Female	43.5	0.74	-0.13	0.0045	2.377

Table 6.13.2.2 Deep-water rose shrimp in GSA 9. Input parameters for XSA.

Catch at age (thousands)	Age 0	Age 1	Age 2	Age 3+
2006	4924.3	26312.2	6957.2	1760.7
2007	4872.0	13339.6	3390.2	0.0
2008	9717.7	20689.9	2271.0	0.0
2009	13071.0	22068.3	3395.0	0.0
2010	7504.3	40079.0	4044.3	622.8
2011	33199.1	39825.8	2322.1	1391.8
2012	7619.9	44708.5	6787.7	693.9
2013	12103.8	42176.3	3801.0	1595.7
2014	26556.7	37541.2	4422.6	1511.6
2015	57461.2	55556.0	4262.0	947.1

Mean weight at age (Catches)	Age 0	Age 1	Age 2	Age 3+
2006	0.0047	0.0116	0.0182	0.0238
2007	0.0046	0.0124	0.0181	0.0236
2008	0.0051	0.0098	0.0187	0.0238
2009	0.0034	0.0112	0.0176	0.0232
2010	0.0040	0.0096	0.0181	0.0232
2011	0.0029	0.0112	0.0177	0.0231
2012	0.0043	0.0102	0.0178	0.0241
2013	0.0030	0.0110	0.0177	0.0233
2014	0.0030	0.0110	0.0177	0.0233
2015	0.0030	0.0110	0.0177	0.0233

Mean weight at age (Stock)	Age 0	Age 1	Age 2	Age 3+
2006	0.0047	0.0116	0.0182	0.0238
2007	0.0046	0.0124	0.0181	0.0236
2008	0.0051	0.0098	0.0187	0.0238
2009	0.0034	0.0112	0.0176	0.0232
2010	0.0040	0.0096	0.0181	0.0232
2011	0.0029	0.0112	0.0177	0.0231
2012	0.0043	0.0102	0.0178	0.0241
2013	0.0030	0.0110	0.0177	0.0233
2014	0.0030	0.0110	0.0177	0.0233
2015	0.0030	0.0110	0.0177	0.0233

Proportion of mature	Age 0	Age 1	Age 2	Age 3+
2006	0.0	0.8	1.0	1.0
2007	0.0	0.8	1.0	1.0
2008	0.0	0.8	1.0	1.0
2009	0.0	0.8	1.0	1.0
2010	0.0	0.8	1.0	1.0
2011	0.0	0.8	1.0	1.0
2012	0.0	0.8	1.0	1.0
2013	0.0	0.8	1.0	1.0
2014	0.0	0.8	1.0	1.0
2015	0.0	0.8	1.0	1.0

Natural mortality	Age 0	Age 1	Age 2	Age 3+
2006	1.45	0.60	0.43	0.35
2007	1.45	0.60	0.43	0.35
2008	1.45	0.60	0.43	0.35
2009	1.45	0.60	0.43	0.35

2010	1.45	0.60	0.43	0.35
2011	1.45	0.60	0.43	0.35
2012	1.45	0.60	0.43	0.35
2013	1.45	0.60	0.43	0.35
2014	1.45	0.60	0.43	0.35
2015	1.45	0.60	0.43	0.35

Tuning MEDITS data	Age 0	Age 1	Age 2	Age 3+
2006	15.0	198.8	54.7	10.3
2007	63.4	73.2	26.2	3.1
2008	80.3	250.8	26.0	5.1
2009	160.3	203.8	33.4	4.1
2010	345.5	541.6	56.1	5.8
2011	438.1	479.8	45.6	7.3
2012	160.4	547.3	70.6	9.0
2013	320.1	423.8	65.1	7.5
2014	399.1	323.9	36.9	5.7
2015	441.3	739.8	52.4	6.2

Results
XSA was run setting shrinkage at 1.0, 1.5, 2.0, 2.5 and 3.0. As showed by Figure 6.13.2.3 the five different settings produced similar estimates of recruitment and SSB.

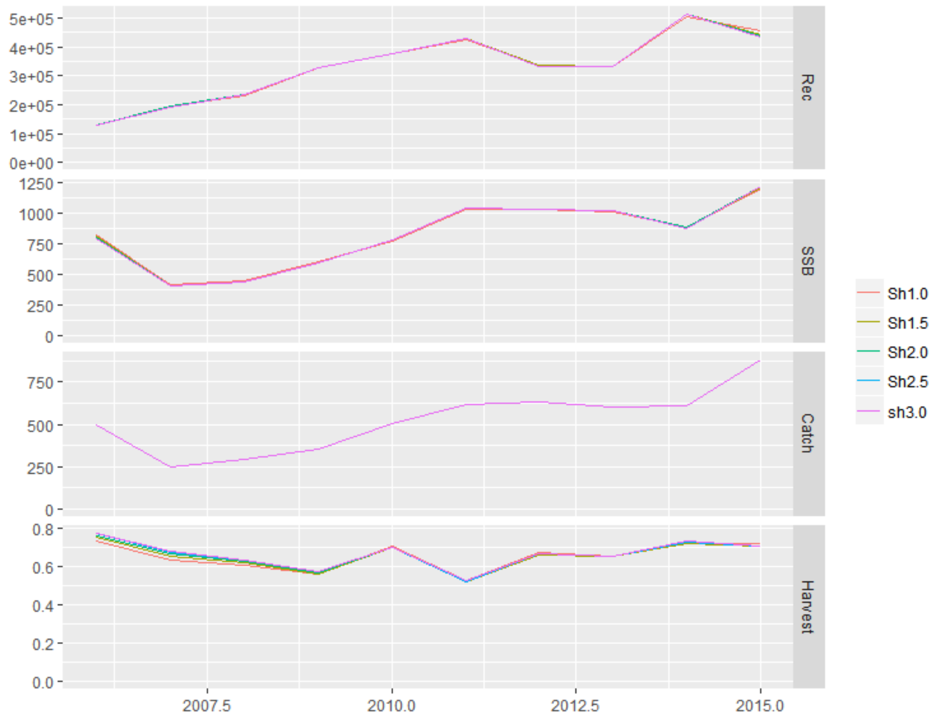


Figure 6.13.2.3. Deep-water rose shrimp in GSA 9. XSA outputs for different shrinkage scenarios. The model with 2.0 shrinkage was adopted as final model based on the analysis of residual distributions (Figure 6.13.2.4). Residuals from tuning fleets (MEDITS) per age and year were relatively low, ranging from 1 to - 1, and did not show any trend with time.

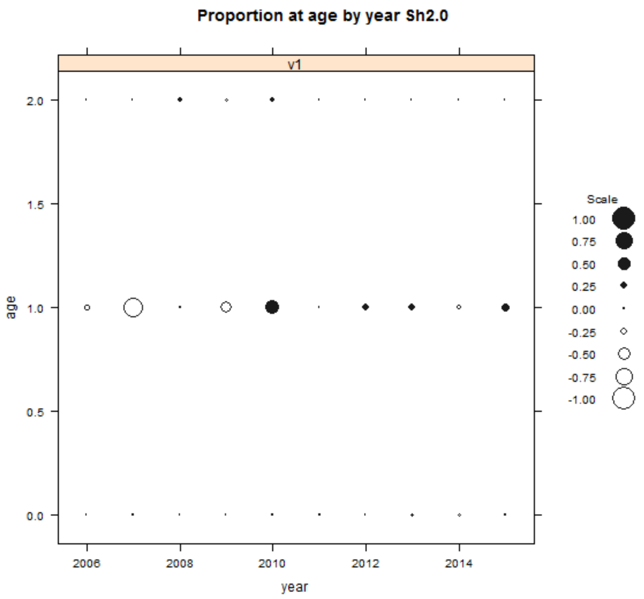


Figure 6.13.2.4. Deep-water rose shrimp in GSA 9. Residuals at age obtained with shrinkage set at 2.0.

Additionally, a retrospective analysis was conducted on recruitment, mean F and SSB (Figure 6.13.2..5) to ensure the robustness of the final estimates. The retrospective series indicate very good agreement between years in the assessment results, with no systematic bias.

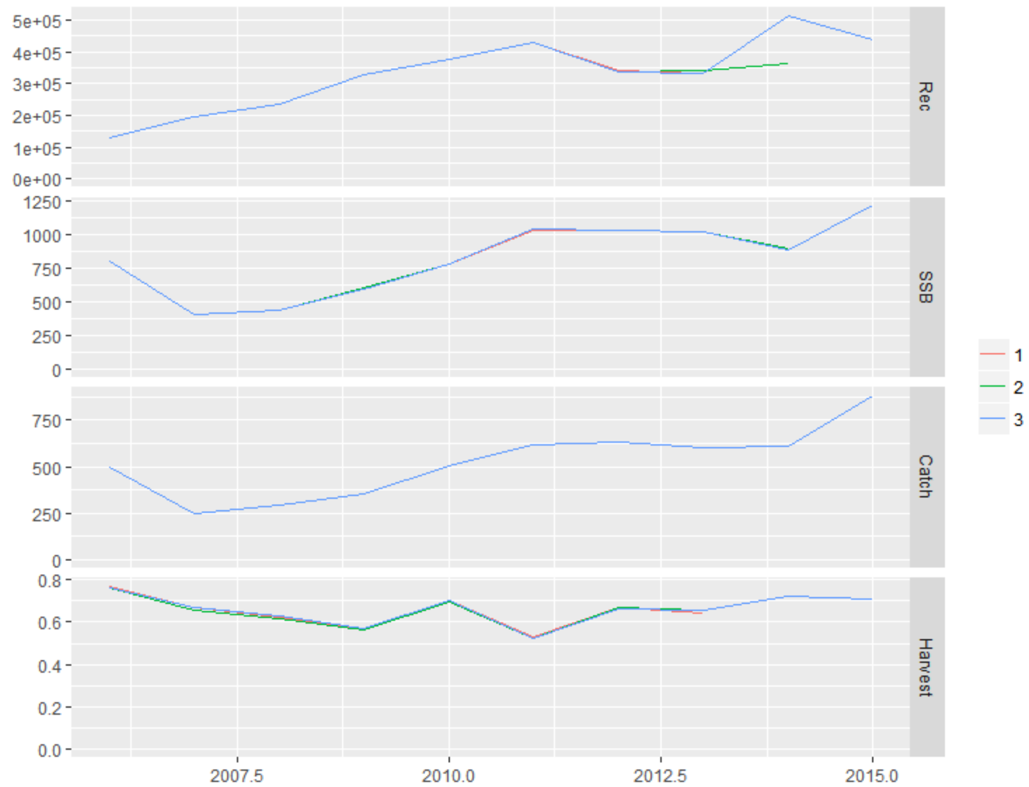


Figure 6.13.2.5. Deep-water rose shrimp in GSA 9. Retrospective analysis with shrinkage set at 2.0.

Based on these sensitivity analyses, the inputs reported in Table 6.13.2.1 were selected to run the final XSA.

Table 6.13.2.1. Deep-water rose shrimp in GSA 9. Inputs selected to run the final XSA.

fse	rage	qage	shk.n	shk.f	shk.yrs	shk.ages
2.0	0.0	2.0	TRUE	TRUE	5.0	2.0

XSA main outputs (Figure 6.13.2.6) showed an increasing trend in the catches, recruitment and SSB. In the case or recruitment, a slightly decrease was observed in the last year. Recruitment varied from a minimum of 129 million in 2006 to 514 million in 2014. The highest values of SSB and catches were observed in 2015 (1213.7 tons). Fishing mortality is characterized by a slight decreasing trend in the first part of the time series (2006-2011) and then the trend is reversed from 2011. F_{curr} in 2015 was 0.708. The total biomass of the stock ranged between 1372.5 tons in 2007 and 2744.4 tons in 2015. XSA stock summary results are reported in the Tabs. 6.13.2.2 to 6

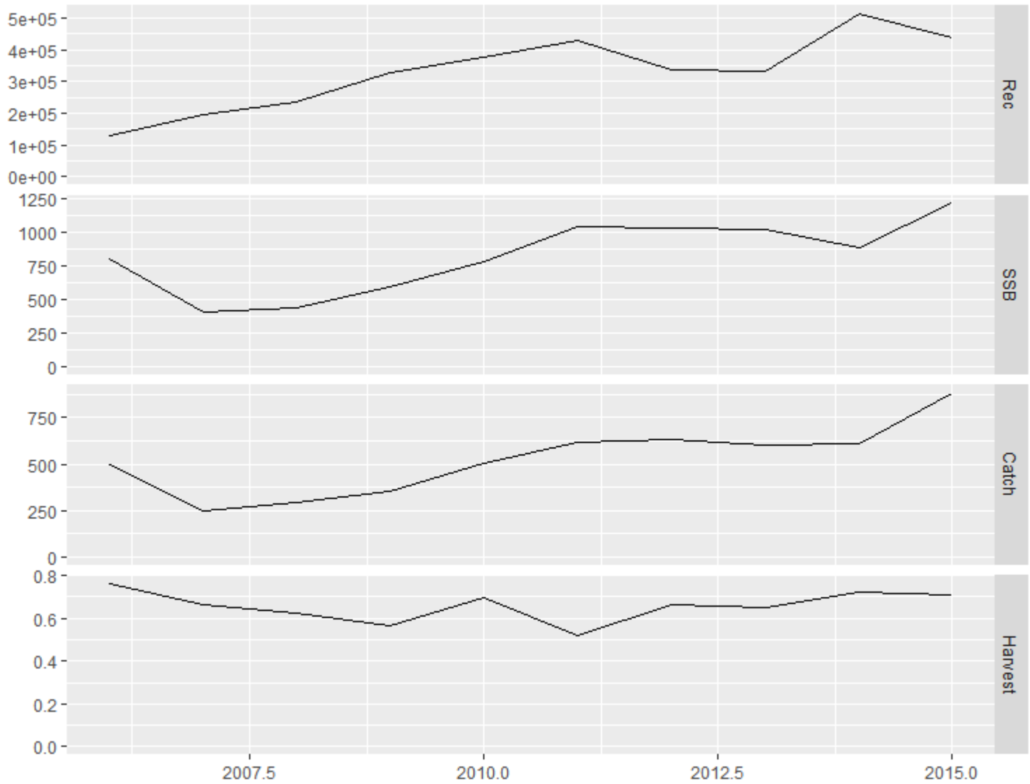


Figure 6.13.2.6. Deep-water rose shrimp in GSA 9. XSA summary results. SSB and catch are in tons, recruitment in thousands of individuals.

Table 6.13.2.2 Deep-water rose shrimp in GSA 9. Stock numbers-at-age (thousands) as estimated by XSA.

Age	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
0	129213	194098	233959	329320	376888	430741	334733	332944	514047	436771
1	48515	27852	43059	50042	70733	84556	84728	74636	72049	107433
2	14688	7093	5378	8266	11069	9070	16826	13307	9656	11669
3+	3574	0	0	0	1655	5321	1665	5456	3178	2518

Table 6.13.2.3 Deep-water rose shrimp in GSA 9. XSA summary results.

	F_{bar0-2}	Recruitment (thousands)	SSB (t)	TB (t)
2006	0.764	129213	801.2	1520.1
2007	0.666	194098	405.4	1372.5
2008	0.627	233959	437.1	1715.9
2009	0.569	329320	595.7	1816.2
2010	0.700	376888	778.7	2425.9
2011	0.523	430741	1040.7	2465.9
2012	0.664	334733	1034.0	2661.7
2013	0.653	332944	1021.5	2172.3
2014	0.724	514047	881.0	2562.5
2015	0.708	436771	1213.7	2744.4

Table 6.13.2.4 Deep-water rose shrimp in GSA 9. XSA summary results: F-at-age matrix.

	F-at-age			
	0	1	2	3+
2006	0.082	1.320	0.888	0.888
2007	0.053	1.042	0.901	0.901
2008	0.090	1.048	0.744	0.744
2009	0.086	0.906	0.714	0.714
2010	0.042	1.451	0.605	0.605
2011	0.174	1.012	0.383	0.383
2012	0.048	1.249	0.696	0.696
2013	0.078	1.443	0.438	0.438
2014	0.113	1.218	0.842	0.842
2015	0.317	1.200	0.605	0.605

Method 2. Length-based analysis

Length-based methods were used for deriving some indicators explored in WKLIFE IV. (ICES, 2015). They allow classifying the stocks according to conservation/sustainability, yield optimization and MSY considerations. Analysis required data on the stock catch/landings–length composition and life-history parameters as Linf.

The length-based indicators analysis was performed using the commercial landings in 2006 to 2015 (discards considered negligible) and the following life-history parameters: Linf=43.5 mm.

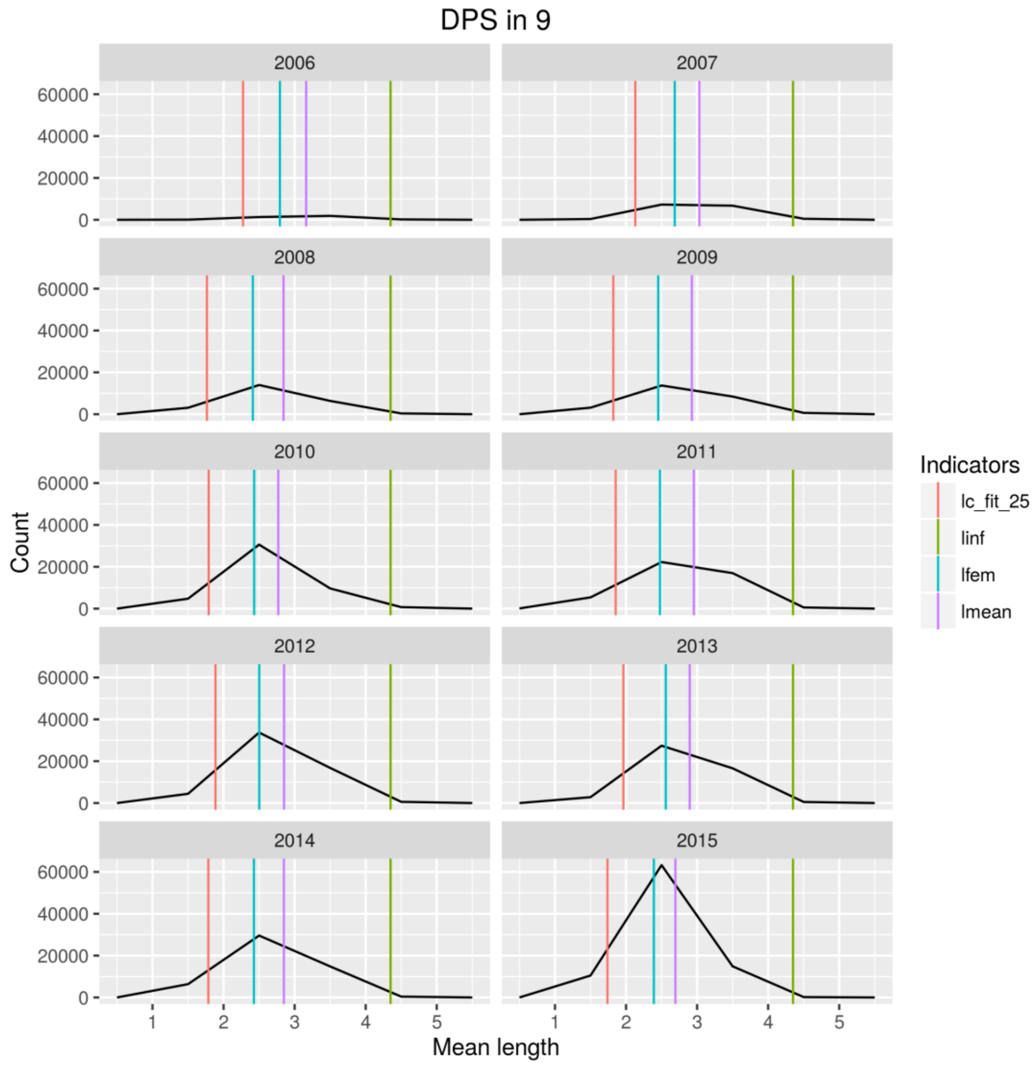


Figure 6.13.2.8. Deep-water rose shrimp in GSA 9. Length-based indicators and reference points for rose shrimp using the catch length composition for 2006, to 2015

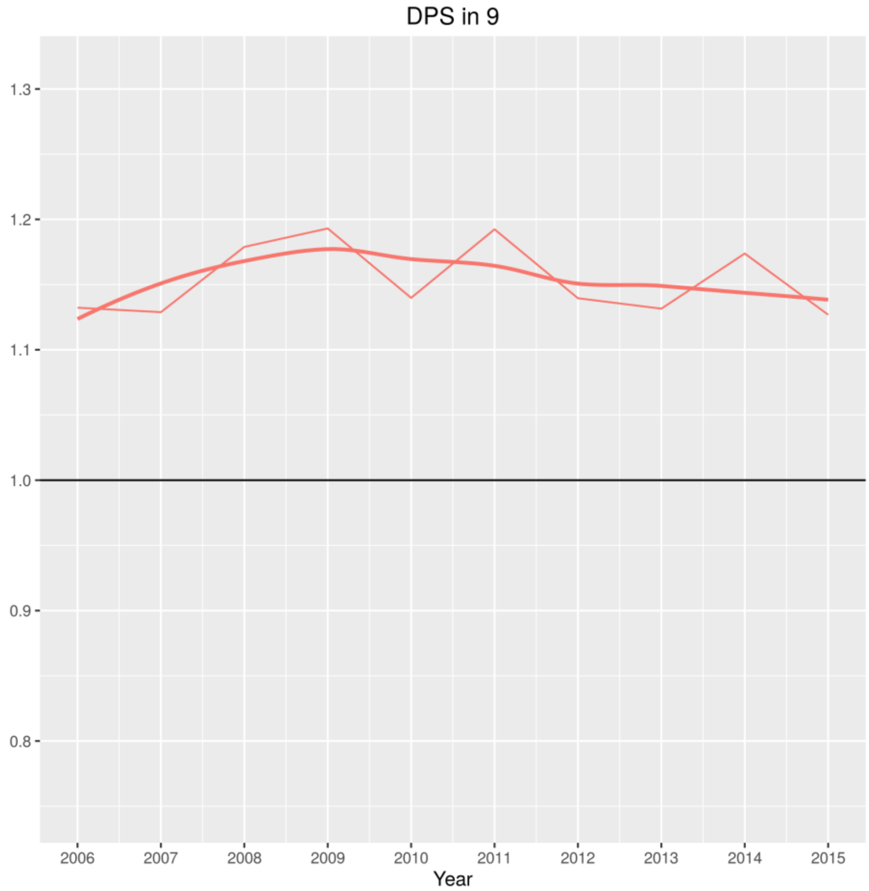


Figure 6.13.2.9. Deep-water rose shrimp in GSA 9. Length-based indicator for rose shrimp using the catch length composition for 2006 to 2015

The overall perception from length-based indicators is that the stock is being fished below MSY level. Such a perception supports the results obtained from XSA assessments. The level suggests exploitation more below Fmsy than the assessment; this may be due to the difference in definition of FMSY proxy for the assessment and the length indicator. The indicator also supports the view of decreasing F over the early part of the time series followed by a slight increase in F in the later years.

6.13.3 REFERENCE POINT

The time series of SSB and R values is not sufficient to allow evaluation of S-R elements of MSY, so the WG has applied the STECF recommended method of F0.1. The yield per recruit (YpR) analysis was run using NOAA software. The analysis was performed to estimate $F_{0.1}$ as target equilibrium YPR reference point for the stock. YpR output curve is illustrated in the Figure 6.13.3.1 while in Figure 6.13.3.2 $F_{0.1}$ and F_{bar} are compared. $F_{0.1}$ estimated by the model was 0.71.

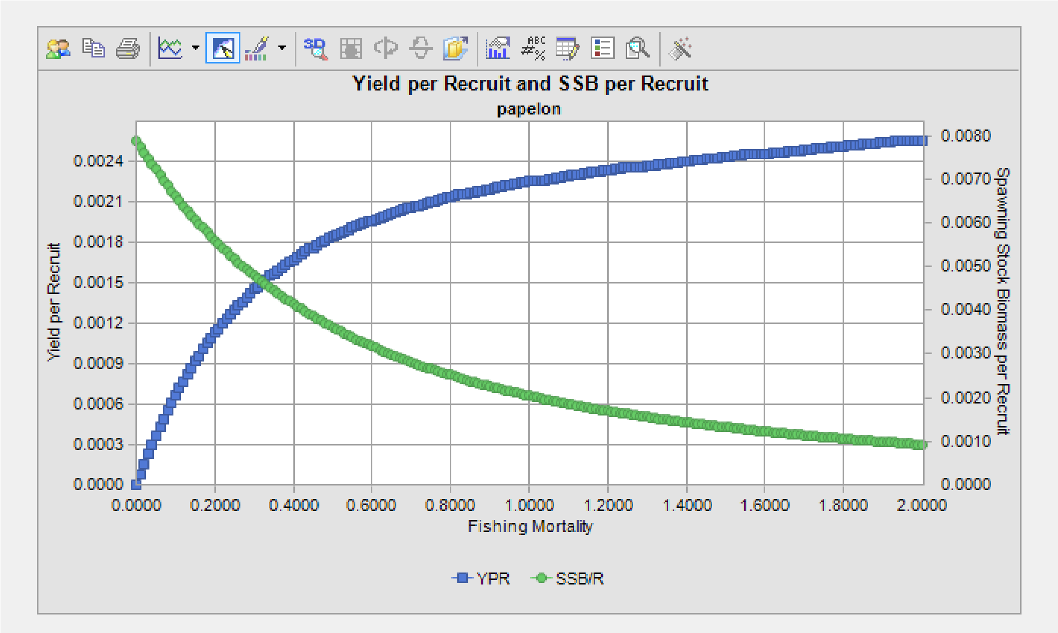


Figure 6.13.3.1. Deep-water rose shrimp in GSA 9. Yield per Recruit curve.

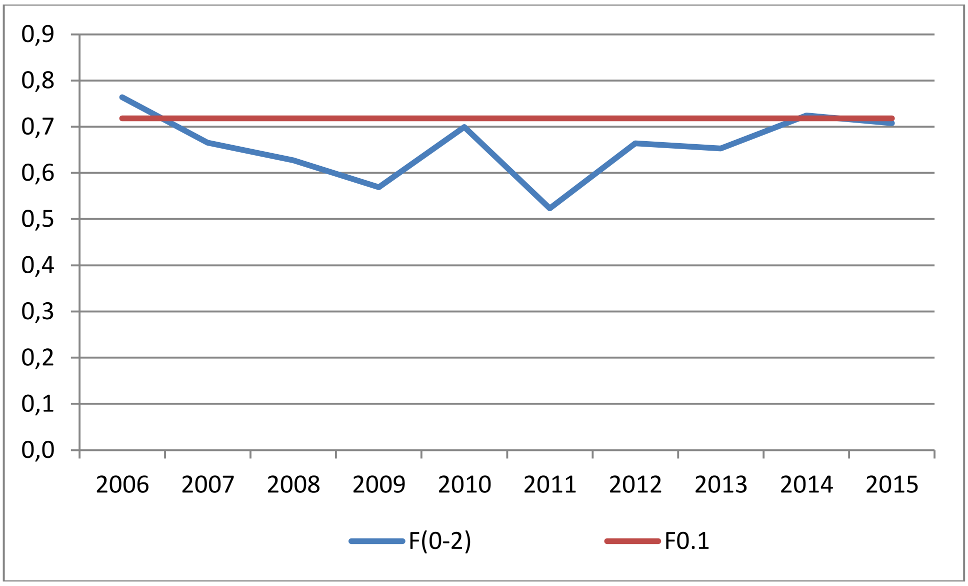


Figure 6.13.3.2. Deep-water rose shrimp in GSA 9. Trend of F_{bar} obtained by means of XSA and comparison with $F_{0.1}$.

According to the F estimates obtained using landing and discard data with XSA, F_{curr} was below the estimated reference value of $F_{0.1}$=0.71 with the only exception of 2006 and 2014. STECF-EWG 16-17 considers the stock has been harvested sustainably (fully exploited) consistent with high long term yield and lower risk of stock collapse. It is important to consider that this stock could be strongly driven by environmental and ecological factors (e.g. water temperature, predatory release effect) that can make difficult to evaluate the effect of fishing on the stock. EWG 16-17 advises to not increase the current level of effort of the relevant fleets, in order to avoid future loss in stock productivity.

6.13.4 SHORT TERM FORECAST

A deterministic short term prediction for the period 2016 to 2018 was performed using the FLR routines and based on the results of the XSA stock assessment.

The input parameters for the deterministic short-term predictions for the period 2016 to 2018 were the same used for the XSA stock assessment and its results. An average of the last three years has been used for weight at age, maturity at age and F at age.

Recruitment (age 0) has been estimated from the population results as the geometric mean of the last 3 years (460566 thousand individuals).

Table 6.13.4.1 Deep-water rose shrimp in GSA 9. Short term forecast in different F scenarios 3 year average (2013-15) weight at age, maturity at age and F at age. Recruitment (age 0) geomean 2013-15 (460566 thousand individuals).

Rationale	Ffactor	Fbar	Catch 2015	Catch 2016	Catch 2017	Catch 2018	SSB 2017	SSB 2018	Change SSB 2017-2018(%)	Change Catch 2015-2017(%)
Zero catch	0	0	881	748	0	0	1121	1978	76.5	-100.0
High long term yield (F0.1)	1.022	0.710	881	748	798	791	1121	1107	-1.2	-9.4
Status quo	1	0.695	881	748	788	786	1121	1118	-0.2	-10.6
Different Scenarios	0.2	0.139	881	748	218	290	1121	1731	54.4	-75.2
	0.3	0.209	881	748	313	400	1121	1625	45.0	-64.4
	0.4	0.278	881	748	400	491	1121	1530	36.5	-54.6
	0.5	0.348	881	748	479	566	1121	1443	28.8	-45.6
	0.6	0.417	881	748	551	628	1121	1365	21.8	-37.4
	0.7	0.487	881	748	618	680	1121	1295	15.5	-29.9
	0.8	0.556	881	748	679	722	1121	1230	9.8	-22.9
	0.9	0.626	881	748	735	757	1121	1172	4.5	-16.5
	1.1	0.765	881	748	836	810	1121	1069	-4.6	-5.1
	1.2	0.834	881	748	881	829	1121	1024	-8.6	-0.0
	1.3	0.904	881	748	922	844	1121	983	-12.3	4.7
	1.4	0.973	881	748	961	856	1121	944	-15.7	9.1
	1.5	1.043	881	748	997	866	1121	909	-18.9	13.2
	1.6	1.112	881	748	1031	874	1121	877	-21.8	17.1
	1.7	1.182	881	748	1063	880	1121	846	-24.5	20.7
	1.8	1.251	881	748	1093	884	1121	818	-27.0	24.1
	1.9	1.321	881	748	1121	887	1121	792	-29.3	27.3
	2	1.390	881	748	1147	889	1121	767	-31.5	30.3

6.13.5 QUALITY AND PROPOSALS FOR FUTURE ASSESSMENTS

Data from EU DCF as submitted through the Official data call in 2016 were used. Length-frequencies distributions (LFD) were missing for the “métier” OTB_DWS. Missing LFDs were borrowed from other OTB segments. EU DCF data prior to 2006 were considered incomplete; therefore, they were not used for the stock assessment.

Discards data were missing for 2007 and 2008 as their collection was not compulsory. Discards for OTB those two years were estimated as the mean discard of the entire time-series. The LFD of OTB discards of 2009 were used to raise the discards.

One set of biological parameters (growth parameters, sex-ratio) has been furnished for the period 2006-2015.

6.14 DEEP-WATER ROSE SHRIMP IN GSA 10

6.14.1 DATA GATHERING OF DEEP-WATER ROSE SHRIMP IN GSA 10

6.14.1.1 Stock Identity and Biology

The stock of deep-water rose shrimp was assumed in the boundaries of the whole GSA10, lacking specific information on the stock identification. The rose shrimp is an epibenthic species and inhabits the muddy or sandy- muddy bottoms of the continental shelf. A gradient of size increasing with depth has been observed in GSA 10 as in other areas, the smallest specimens are fished more frequently in the upper part of the continental shelf (100-200 m), while the largest ones are mainly distributed along the slope at depths greater than 200 m (Spedicato *et al*., 1996). Aggregations with higher abundance were localised between 100 and 200 m depth, with some intrusions in the deeper waters in three sub-areas. Two most important patches were located in the Gulf of Naples and along the Calabrian coasts in correspondence with Cape Bonifati, while a third one in the Gulf of Salerno (Lembo *et al*., 1999). These are the areas where also the main nurseries are localised (Lembo *et al*., 2000). In the Central-Southern Tyrrhenian Sea the occurrence of mature females was observed in spring (May), summer (July-August) and autumn (October), with a higher relative frequency in spring-summer seasons (Spedicato *et al*., 1996). Thus, a continuous recruitment pattern is shown which, however, exhibits a main pulse in the autumn season. At 16 mm carapace length the rose shrimp is considered recruited to the grounds (SAMED, 2002).

The overall sex ratio is about 0.5. The structure of the sizes of *P. longirostris* is characterised by differences in growth between the sexes, the larger individuals being females. The rose shrimp is a short-living crustacean with a life span of about 4 years (Carbonara *et al*., 1998).

The deep-water rose shrimp with hake and red mullet is a key species of fishing assemblages in the central-southern Tyrrhenian Sea. In the last decade it was generally also ranked among the species with higher abundance indices (number of individuals) in the trawl surveys (e.g. Spedicato *et al*. 2003) as observed for different Mediterranean areas (Abelló *et al*., 2002). The rose shrimp is caught on the same fishing grounds as European hake and red mullet and the production of this shrimp is generally growing in the last decade in the southern basin and it reached in 2015 about 17% of the trawlers landings.

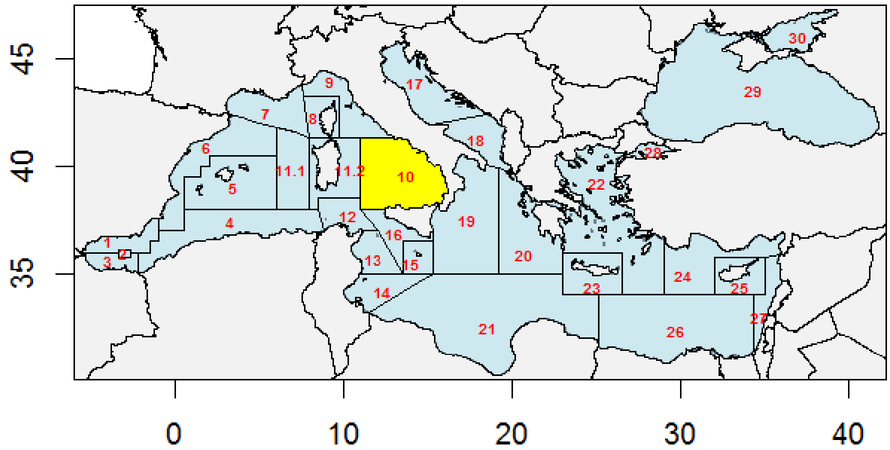


Figure 6.14.1.1.1 Geographical location of GSA 10.

Growth

Past estimates of the growth pattern of the rose shrimp females were obtained using different methods based on the LFD analysis (modal progression analysis-MPA, Elefan, Multifan) applied to GRUND data from 1990 to 1995. Parameters of VBGF were as follows: L_∞=45.9; K=0.673 t_0= -0.251 (Carbonara *et al.*, 1998). VBGF parameters were also re-estimated during the Samed project (SAMED, 2002) using the MEDITS time series from 1994 to 1999, that gave the following values: females: CL_∞=45.0 mm, K=0.7, t_0= -0.15; males: CL_∞=40.0 mm; K=0.78; t_0= -0.2. Maximum carapace lengths (CL) observed for females and males were respectively 42.3 mm and 39 mm. The Table 6.14.1.1-1 summarizes the estimated obtained by the DCF Data Call for the von Bertalanffy growth parameters and the length-weight relationship.

Table 6.14.1.1.1. Deep-water rose shrimp in GSA 10. Summary of the estimated obtained by the DCF Data Call for the von Bertalanffy growth parameters and the length-weight relationships.

AREA	START YEAR	END YEAR	SPECIES	SEX	VB_LINF	VB_K	VB_T0	A	B
SA 10	2003	2005	DPS	F	46	0.575	-0.2	0.0028	2.5180
SA 10	2003	2005	DPS	M	40	0.68	-0.25	0.0039	2.3890
SA 10	2006	2006	DPS	F	46	0.575	-0.2	0.0033	2.4523
SA 10	2006	2006	DPS	M	40	0.68	-0.25	0.0045	2.3354
SA 10	2007	2007	DPS	F	46	0.575	-0.2	0.0033	2.4523
SA 10	2007	2007	DPS	M	40	0.68	-0.25	0.0045	2.3354
SA 10	2008	2008	DPS	F	46	0.575	-0.2	0.0033	2.4523
SA 10	2008	2008	DPS	M	40	0.68	-0.25	0.0045	2.3354
SA 10	2009	2009	DPS	F	46	0.575	-0.2	0.0027	2.5090
SA 10	2009	2009	DPS	M	40	0.68	-0.25	0.0032	2.4425
SA 10	2010	2010	DPS	F	46	0.575	-0.2	0.0033	2.4560
SA 10	2010	2010	DPS	M	40	0.68	-0.25	0.0034	2.4238
SA 10	2011	2011	DPS	F	46	0.575	-0.2	0.0030	2.4890
SA 10	2011	2011	DPS	M	40	0.68	-0.25	0.0038	2.3978
SA 10	2012	2012	DPS	F	46	0.575	-0.2	0.0041	2.3853
SA 10	2012	2012	DPS	M	40	0.68	-0.25	0.0044	2.3436
SA 10	2013	2013	DPS	F	46	0.575	-0.2	0.0032	2.4576
SA 10	2013	2013	DPS	M	40	0.68	-0.25	0.0028	2.4965

SA 10	2014	2014	DPS	F	46	0.575	-0.2	0.0034	2.4278
SA 10	2014	2014	DPS	M	40	0.68	-0.25	0.0041	2.3546
SA 10	2015	2015	DPS	F	46	0.575	-0.2	0.0021	2.5801
SA 10	2015	2015	DPS	M	40	0.68	-0.25	0.0026	2.5126

For the present assessment the growth parameters and the length-weight relationship parameters reported in the table 6.14.1.1-1 have been used.

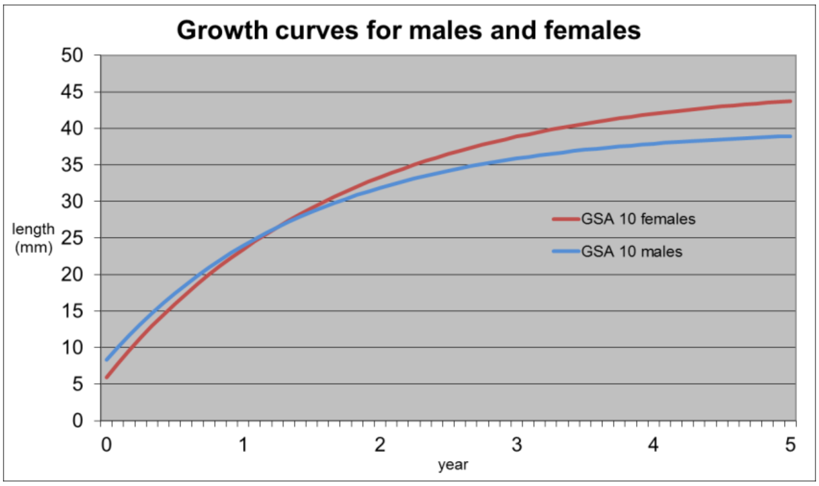


Figure 6.14.1.1.2. Deep-water rose shrimp in GSA 10. Deep-water rose shrimp growth function for females and males in GSA10 used in the present assessment.

Maturity

The maturity ogive (Figure 6.14.1.1-3) was obtained from a maximum likelihood procedure applied grouping as mature individuals belonging to the maturity stage 2b-2e (according to the MEDITS maturity scale). The fitting of the curve was fairly good. The estimates of the size at first maturity $L_{m50\%}$ and the maturity range are respectively 14.6 ± 0.04 mm and 4 ± 0.059 mm (from DCF sex combined commercial data, 2015).

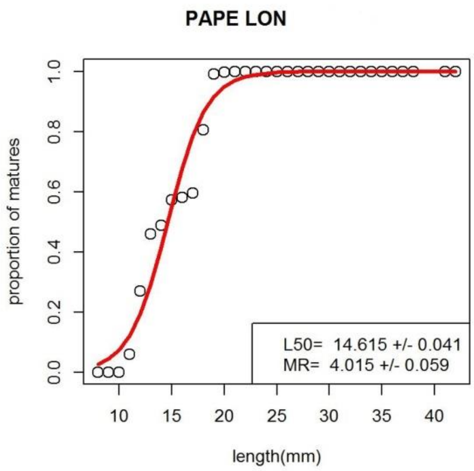


Figure 6.14.1.1.3. Deep-water rose shrimp in GSA 10. Maturity ogives and proportions of mature for combined sex of deep-water rose shrimp in the GSA 10 (MR indicates the difference $Lm_{75\%}$-$Lm_{25\%}$) from DCF commercial data 2015.

The observed maximum length of deep-water rose shrimp was 47 mm for females and 41 mm for males both registered in the survey.

In the table 6.14.1.1-2 the maturity proportion at age adopted in the present assessment is reported. The maturity indicated in the Table is the proportion of matures individual corresponding to the length at the beginning of each age class (e.g. for age 0 the maturity is the one of individuals 1 month old).

Table 6.14.1.1.2. Deep-water rose shrimp in GSA 10. Maturity proportion at age adopted in the present assessment.

Proportion of mature	Age 0	Age 1	Age 2	Age 3+
Sex combined	0.01	0.99	1	1

Natural mortality

For the present assessment, in line with the previous ones, the vector of natural mortality estimated according to PRODBIOM (Abella et al., 1997) and reported in the Table 6.14.1.1-3 has been adopted. However, a sensitivity analysis with a different hypothesis of natural mortality (Chen and Watanabe method) has been carried out (see Section 6.14.2).

Table 6.14.1.1.3. Deep-water rose shrimp in GSA 10. Vector of natural mortality used in the present assessment.

Natural mortality	Age 0	Age 1	Age 2	Age 3+
Sex combined	1.41	0.81	0.7	0.7

6.14.1.2 Catch data

Catches

Total catch by year is reported in Table 6.14.1.2-1 (in term of landing and discard) and figure 6.14.1.2-1. Being not available in 2004-2005 and 2007-2008, discards have been estimated on the basis of the ratio averaged in the nearest available years (2006 and 2009-2011).

Table 6.14.1.2.1. Deep-water rose shrimp in GSA 10. Catches in terms of landings and discards (tons).

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total landing (All Gears)	552	776	1089	534	400	379	370	405	459	597	509	547
Discard (only trawlers)	4.7	6.5	3.9	4.7	3.5	7.3	2.6	1.9	3.5	9.4	3.3	13.3
Total	**557**	**783**	**1093**	**539**	**404**	**386**	**373**	**407**	**463**	**606**	**512**	**560**

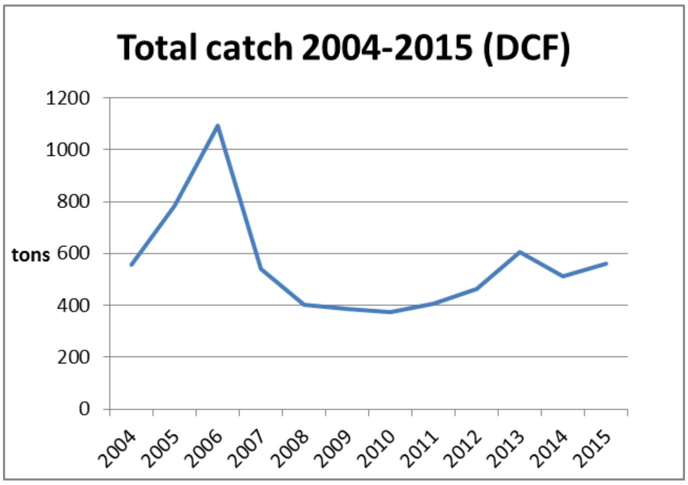


Figure 6.14.1.2.1. Deep-water rose shrimp in GSA 10. Total catch (tons), 2004-2015.

For the present assessment, age distribution of deep-water rose shrimp (catches) in GSA 10 has been obtained as sum of landing and discard age distribution from DCF estimated using the LFDA algorithm slicing method with the growth parameters reported in Table 6.14.1.1-1. Age distributions of catches are reported in Table 6.14.2-1 and figure 6.14.2-1.

Landings

Available landing data collected under the DCF framework ranged from 370 tons (registered in 2010) to 1089 tons (registered in 2006) (Table 6.14.1.2-2). Most part of the landings of rose shrimps was from trawlers (about 93% on average) and landings of gears other than trawlers can be considered negligible or misreporting, so they are not included in the assessment.

Table 6.14.1.2.2. Deep-water rose shrimp in GSA 10. Annual landings for by gear type, 2004-2015.

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Trawlers	544	743	1088	534	400	379	370	402	455	597	509	525
Other gears	8	33	1	0	0.1	0.2	0	3	4	0	0.3	22
Total	**552**	**776**	**1089**	**534**	**400**	**379**	**370**	**405**	**459**	**597**	**509**	**547**

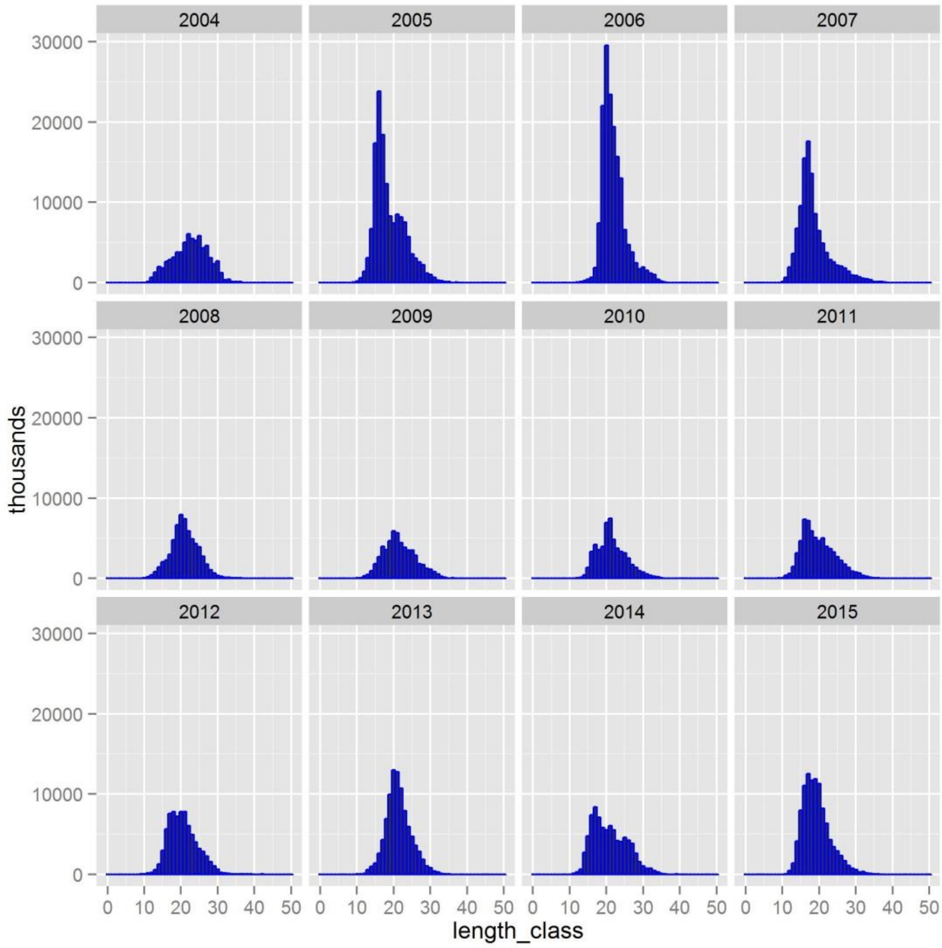


Figure 6.14.1.2.2. Deep-water rose shrimp in GSA 10. Landing distribution by year (thousands).

For the present assessment, age distribution by year of deep-water rose shrimp (landing) in GSA 10 from DCF are reported in Table 6.14.1.2-3 and figure 6.14.1.2-3.

Table 6.14.1.2.3. Deep-water rose shrimp in GSA 10. Landing at age (thousands) by year.

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
0	32343	115418	103195	92546	42395	34230	35941	49345	54485	62344	53712	86346
1	35528	28214	53882	15864	20557	21359	18710	17939	21268	30169	28043	17969
2	638	405	1570	1157	328	488	561	470	256	146	878	362
3+	0.00	24.45	0.00	16.04	2.66	0.33	3.44	0.00	33.91	0.57	8.73	0.01

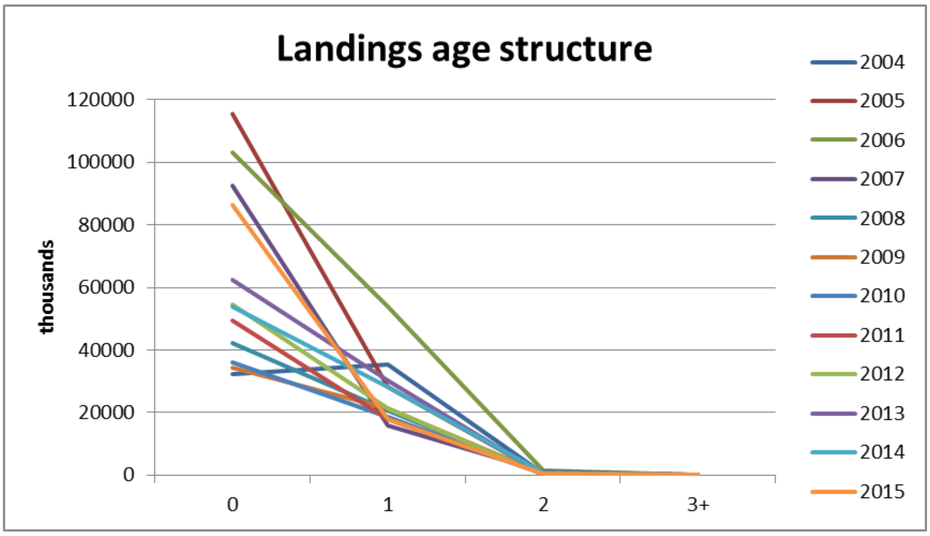


Figure 6.14.1.2.3. Deep-water rose shrimp in GSA 10. Landing at age (thousands) by year.

Discards

The discards of deep-water rose shrimp in the GSA 10 are reported for 2006, 2009-2015, as in 2004, 2005, 2007 and 2008 DCF did not require collection of discard data. The volume of discards is rather variable among years, as usual for discards, however, discarding is in all the years no greater than 2% of the total catch (except for 2015: 2.5%). When not available the volume of discard has been estimated on the basis of the average discard ratio (D/L) in the available years (2006, 2009-2011). The discards have been included in the assessment.

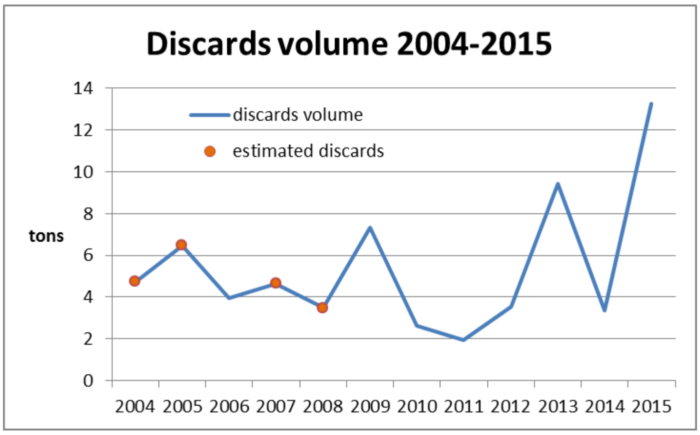


Figure 6.14.1.2.4. Deep-water rose shrimp in GSA 10. Discards by year, 2004-2015. The colored points represents the years in which the volume of discards was not available.

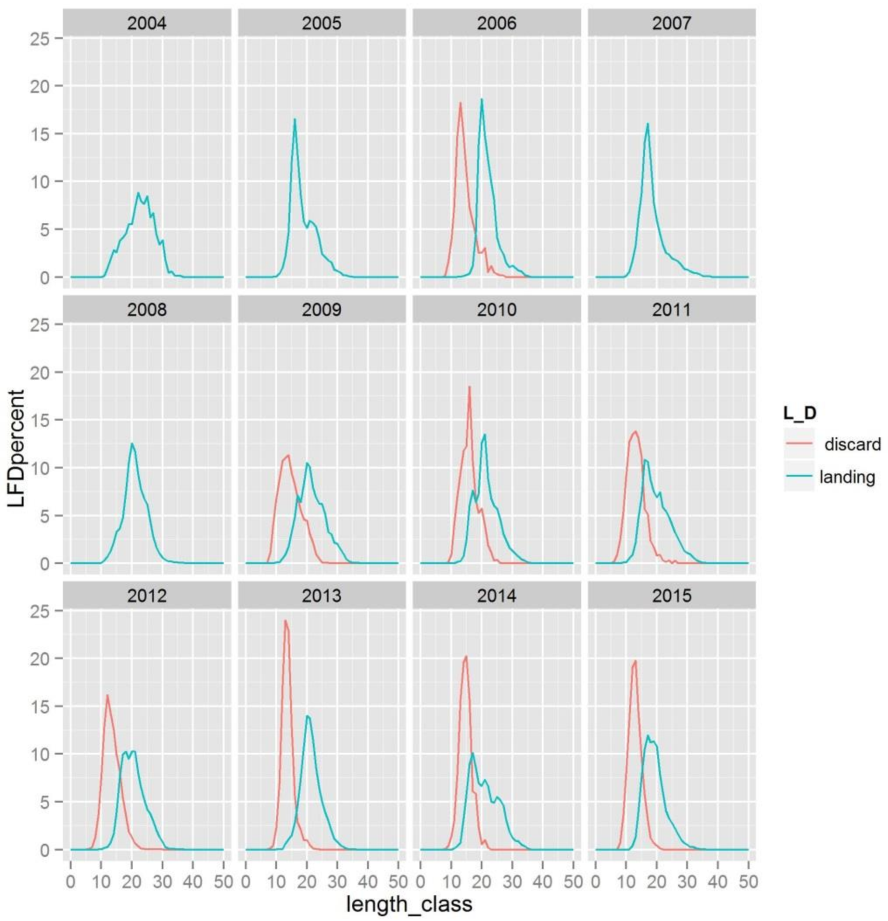


Figure 6.14.1.2.5. Deep-water rose shrimp in GSA10. Landing and discard distribution in percentage at length by year.

6.14.1.3 Fishing effort data

General description of the fisheries

The deep-water rose shrimp is only targeted by trawlers and fishing grounds are located on the soft bottoms of continental shelves and the continental slope along the coasts of the whole GSA. The rose shrimp occurs mainly with *M. merluccius*, *M. barbatus*, *E. cirrhosa*, *I. coindetii and T. eblanae*, *N. norvegicus*, *P. blennoides* depending on depth and area.

Management regulations

Management regulations are based on technical measures, a defined number of fishing licenses for the fleet and area limitation (distance from the coast and depth). In order to limit the over-capacity of fishing fleet, the number of Italian fishing licenses has been fixed since the late eighties. Other measures on which the management regulations are based regard technical measures (mesh size) and minimum landing sizes (EC 1967/06).
After 2000, in agreement with the European Common Policy of Fisheries, a gradual decreasing of the fleet capacity was implemented. Along northern Sicily coasts two main Gulfs (Patti and Castellammare) have been closed to the trawl fishery up 200 m depth, since 1990. In the GSA 10 the fishing ban has not been mandatory along the time, and from one year to the other it was adopted on a voluntary basis by fishers, whilst in the last three years it was mandatory. Regarding long-lines the management regulations are based on technical measures related to

the number of hooks and the minimum landing sizes (EC 1967/06), besides the regulated number of fishing licences.

In 2008 a management plan was adopted, that foresaw the reduction of fleet capacity associated with a reduction of the time at sea. Two biological conservation zone (ZTB) were permanently established in 2009 (Decree of Ministry of Agriculture, Food and Forestry Policy of 22.01.2009; GU n. 37 of 14.02.2009). One is located along the mainland, in front of Sorrento peninsula in the vicinity of the MPA of Punta Campanella (Napoli Gulf, 60 km^2, within 200 m depth) and a second one is along the coasts of Amantea (Calabrian coasts, 75 km^2 up to 250 m depth). In these areas trawling is forbidden and other fishing activities are allowed under permission. Since June 2010 the rules implemented in the EU regulation (EC 1967/06) regarding the cod-end mesh size and the operative distance of fishing from the coasts are enforced.

Fishing effort data

Trend in fishing effort (kW*days) for the main gear type targeting deep-water rose shrimp in GSA 10 from 2002 to 2015 as reported through the DCF official data call is in the Table 6.14.1.3.1 and Figure 6.14.1.3.1. The general trend of OTB fishing effort shows a decrease from 2005 to 2011 and then an increase until 2014, followed by a further decrease in 2015.

Table 6.14.1.3.1. Deep-water rose shrimp in GSA 10. Trend in nominal fishing effort (kW*days) by fleet level from 2002-2015, DCF data.

Year	OTB	DRB	FPO	GND	GNS	GTR	LLD	LLS	LTL	OTM	PS	PTM
2002	7344089	94663				6440217					2631242	
2003	7231486	29540				7222145					2930380	
2004	8070376	86505	0	282086	4049992	3310756	1044137	4563626	0		3934144	6173
2005	8029362	294424	314508	127345	5028180	1740353	1138482	1812527			2586897	
2006	7500584	312180	149669	623598	2954204	4295352	793563	1436447			1890420	
2007	7287211	144186		454015	2154086	3857329	363731	1204444			1716205	
2008	5724631	238122		496680	2506323	3208597	387768	1399622			1188917	
2009	5997764	188909		435913	2525668	2450304	1471790	1010226			1903718	
2010	5603044	209574		112632	2782604	2689599	2469932	1272999			1652686	
2011	5234759	196692	156	44621	2963679	2611624	2130245	1695680	6324		1567061	
2012	6051158	241145	71997	53742	2536182	2697356	1643421	1051670	893		1548326	902
2013	6154030	59508	438492	7667	1904962	2919718	1136408	1339212			1721519	
2014	8797448	88658	130683	38343	2476523	2995387	1036683	2676577	12334	383607	1601791	
2015	5510629	103130	115632	14955	1754386	2265251	2783279	1788172	1809	686978	2179040	

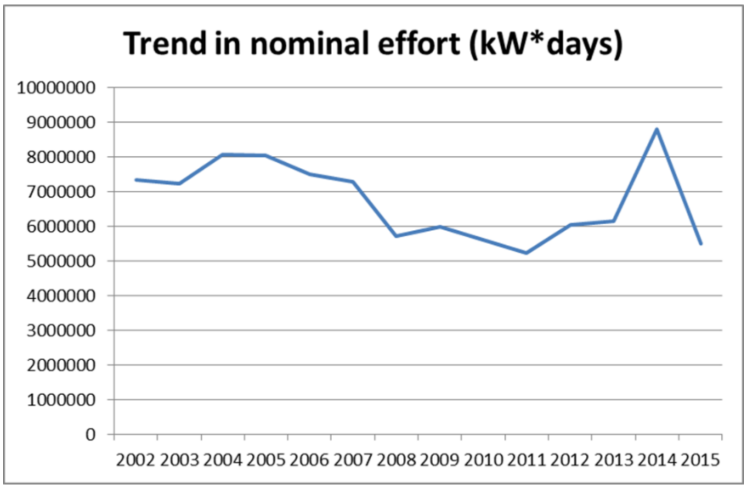


Figure 6.14.1.3.1. Deep-water rose shrimp in GSA 10. Trend in nominal fishing effort (kW*days) for the OTB fleet from 2002-2015, DCF data.

6.14.1.4 Survey Indices of abundance and biomass by year and size/age

MEDITS

Methods

According to the MEDITS protocol (Bertrand *et al*., 2002), trawl surveys were yearly (May-July) carried out, applying a random stratified sampling by depth (5 strata with depth limits at: 50, 100, 200, 500 and 800 m; each haul position randomly selected in small sub-areas and maintained fixed throughout the time). Haul allocation was proportional to the stratum area. The same gear (GOC 73, by P.Y. Dremière, IFREMER-Sète), with a 20 mm stretched mesh size in the cod-end, was employed throughout the years. Detailed data on the gear characteristics, operational parameters and performance are reported in Dremière and Fiorentini (1996). Considering the small mesh size a complete retention was assumed. All the abundance data (number of fish per surface unit) were standardized to square kilometer, using the swept area method.

In GSA 10 the following number of hauls was reported per depth stratum (Table 6.14.1.4.1).

Depth strata	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
10-50	7	8	8	8	8	8	8	8	7	7	7	7	7	7	7	7	7	7	7	7	7	7
50-100	10	10	10	10	10	10	10	10	8	8	8	8	8	8	8	8	8	8	8	7	8	8
100-200	17	17	17	17	17	17	17	17	14	14	14	14	14	14	14	14	14	14	14	14	14	14
200-500	22	23	22	22	22	22	22	24	18	18	18	18	18	18	19	18	18	18	18	18	18	18
500-800	28	27	28	28	28	27	28	26	23	23	23	23	23	23	22	23	23	23	23	23	23	23
Total	**84**	**85**	**85**	**85**	**85**	**84**	**85**	**85**	**70**	**70**	**70**	**70**	**70**	**70**	**70**	**70**	**70**	**70**	**70**	**69**	**70**	**70**

Table 6.14.1.4.1. Deep-water rose shrimp in GSA 10. Number of hauls per depth stratum in MEDITS trawl survey (1994-2015).

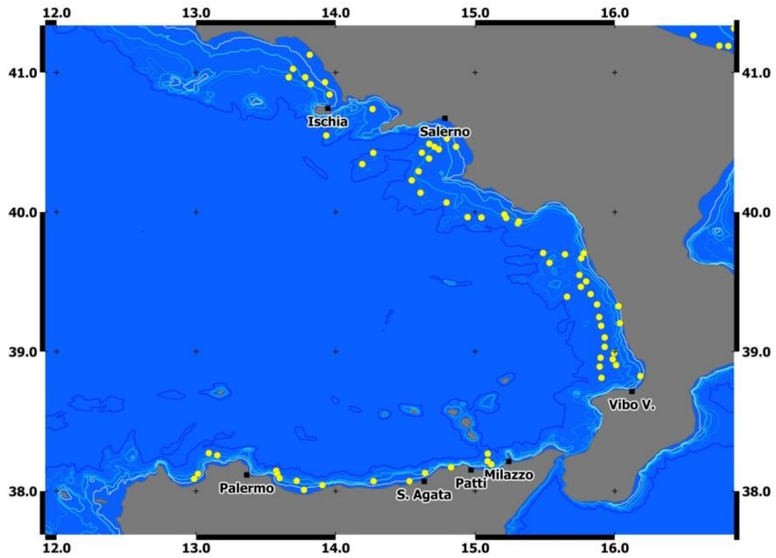


Figure 6.14.1.4.1. Map of MEDITS haul positions in the GSA 10

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Only hauls noted as valid were used, including stations with no catches of rose shrimp (zero catches are included). The density and biomass indices of deep-water rose shrimp in GSA10 were estimated on the depth strata 10-800 m and standardized to km^2.

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in the GSA:

$$Yst = \Sigma (Yi*Ai) / A$$
$$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$$

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

It was noted that while this is a standard approach, the calculation may be biased due to a number of different factors including the change in the number of hauls over time, and change of the survey time over the years. Precision may also be affected by the choice of parametric distribution, a normal distribution is often assumed, whereas data may be better described by a delta-distribution, quasi-Poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien *et al.* 2004).

Length distributions represented an aggregation (sum) of standardized length frequencies distribution raised to standardized haul abundance per square km over the stations of each stratum.

Geographical distribution

The geographical distribution pattern of deep-water rose shrimp has been studied in the area using trawl-survey data and applying geostatistical methods.
Recently in the STOCKMED project (MAREA Framework; Fiorentino et al., 2015) biomass trends (average of the last 10 years) have been estimated (Figure 6.14.1.4-2).

Within MEDISEH project the persistent nurseries and spawning ground have been identified (MEDISEH Project, MAREA Framework; Giannoulaki et al., 2013). In the GSA10 the more persistent nurseries were localized in the Salerno Gulf and in the Castellamare Gulf (Figure 6.14.1.4-3). These areas were also in overlap with spawning grounds. Spawning grounds were however more diffuse in the GSA, with other locations in which adult specimens potentially mature were persistently localized. These sites were off Capo Bonifati, a place already identified in previous studies (Lembo et al., 1999), in the Sant'Eufemia Gulf and in the Patti Gulf (Figure 6.14.1.4-3). In general the grounds are characterised by coastal terrigenous muds (VTC) and detritic bottom (DL) biocoenosis, depending on the zone and depth, inhabited from the shallower facies of Leptometra phalangium (along the shelf) and the deepest facies of Funiculina quadrangularis (along the slope). The direction of the mainstream current is parallel to the coast from south to north.

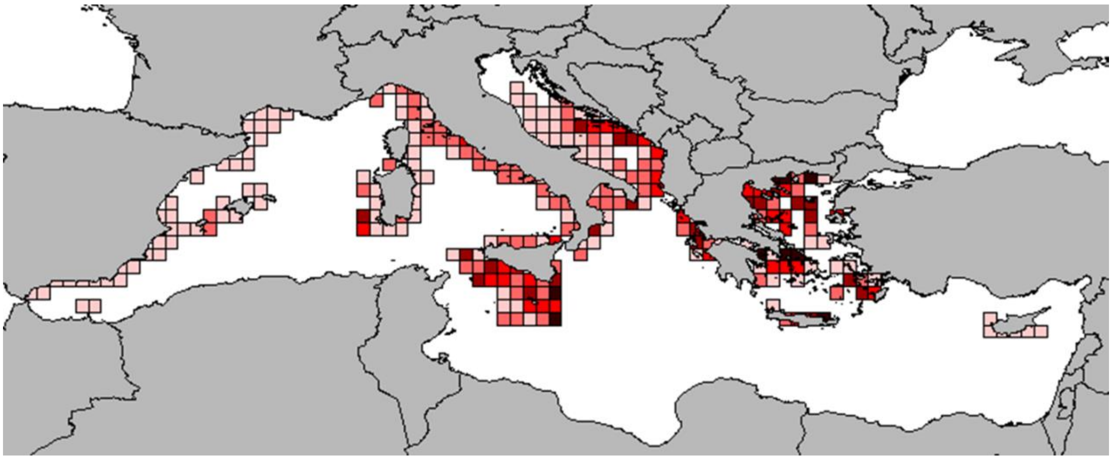


Figure 6.14.1.4.2. Deep-water rose shrimp in GSA 10. Geographical distribution of red mullet in the Mediterranean basin (kg/km^2), STOCKMED Project.

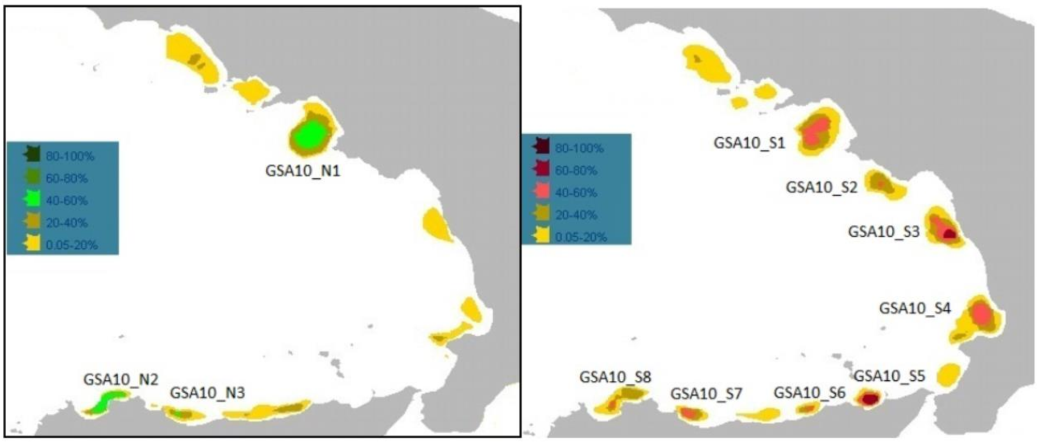


Figure 6.14.1.4.3. Deep-water rose shrimp in GSA 10. Temporal persistence of deep-water rose shrimp nurseries (left) and adults distribution (right) calculated from MEDITS time-series density maps (1994-2012), MEDISEH Project.

Trends in abundance and biomass

Fishery independent information regarding the state of the deep-water rose shrimp in GSA 10 was derived from the international survey MEDITS. Figure 6.14.1.4-4 displays the estimated trend of rose shrimp abundance and biomass indices standardized to the surface unit in the GSA10. Indices from MEDITS trawl-surveys show three peaks in 1999, 2005 and 2012-2013. The trend of abundance indices from MEDITS survey and total landing from commercial catches are overlapped in figure 6.14.1.4-5 generally showing the same trend, especially in the first part of the time series.

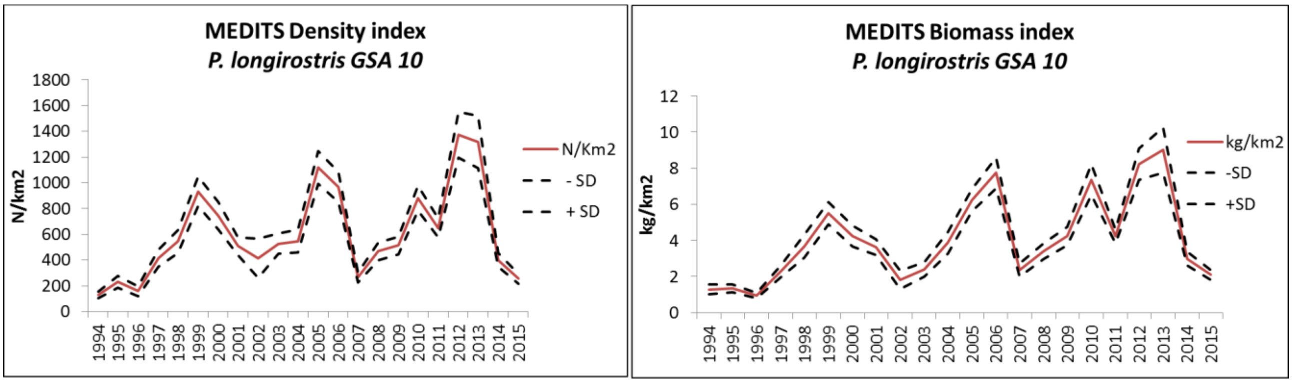


Figure 6.14.1.4.4 Deep-water rose shrimp in GSA 10. Abundance and biomass time series of derived from MEDITS (dotted lines indicated standard deviation).

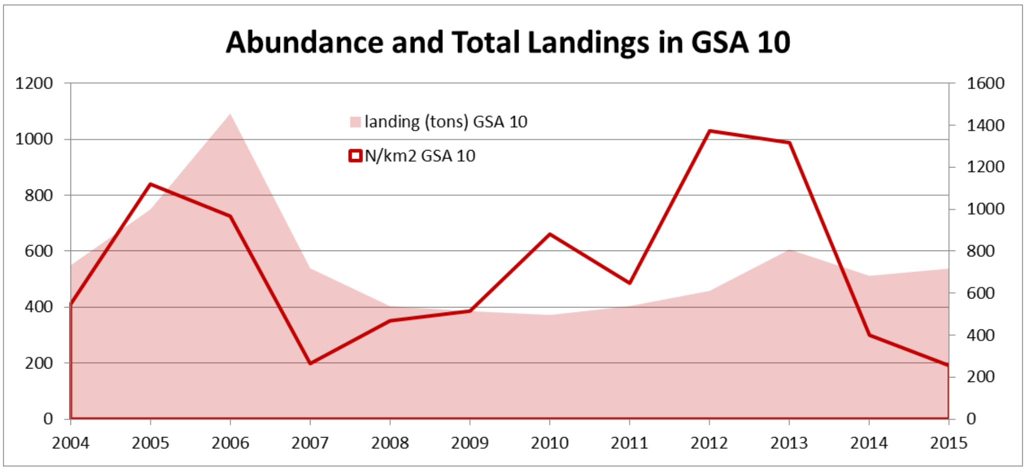


Figure 6.14.1.4.5. Deep-water rose shrimp in GSA 10. Landings (red area) and abundance indices trends in GSA 10, 2004-2015.

Table 6.14.1.4.1. Deep-water rose shrimp in GSA 10. Stratified abundance indices (N/km2 and kg/km2) by year, 1994-2015.

Year	N/Km2	St. Dev	CV (%)	Kg/Km2	St.Dev	CV (%)
1994	129.6	26.3	20.3	1.29	0.27	20.7
1995	232.5	46.1	19.8	1.36	0.22	16.2
1996	159.0	37.3	23.4	0.93	0.14	15.4
1997	412.3	66.5	16.1	2.28	0.32	14.2
1998	545.5	88.9	16.3	3.67	0.63	17.1
1999	933.3	114.7	12.3	5.49	0.61	11.2
2000	741.5	106.7	14.4	4.25	0.58	13.8
2001	509.5	68.0	13.3	3.62	0.45	12.3
2002	414.7	152.3	36.7	1.81	0.52	28.6
2003	527.7	80.1	15.2	2.39	0.39	16.4
2004	546.6	88.4	16.2	3.87	0.60	15.5
2005	1119.7	126.4	11.3	6.22	0.61	9.7
2006	966.9	116.7	12.1	7.73	0.84	10.9
2007	264.9	36.8	13.9	2.36	0.36	15.4
2008	468.8	68.6	14.6	3.41	0.43	12.5

Year	N/Km2	St. Dev	CV (%)	Kg/Km2	St.Dev	CV (%)
2009	515.0	68.4	13.3	4.24	0.49	11.6
2010	881.5	96.1	10.9	7.36	0.85	11.6
2011	647.8	73.7	11.4	4.23	0.39	9.2
2012	1373.3	176.5	12.9	8.22	0.87	10.6
2013	1316.9	203.0	15.4	9.01	1.26	13.9
2014	400.4	53.9	13.5	2.98	0.38	12.7
2015	255.1	39.1	15.3	2.10	0.27	13.0

Trends in abundance by length or age

The figure 6.14.1.4.6 display the stratified abundance indices of deep-water rose shrimp in GSA 10 in 1994-2015.

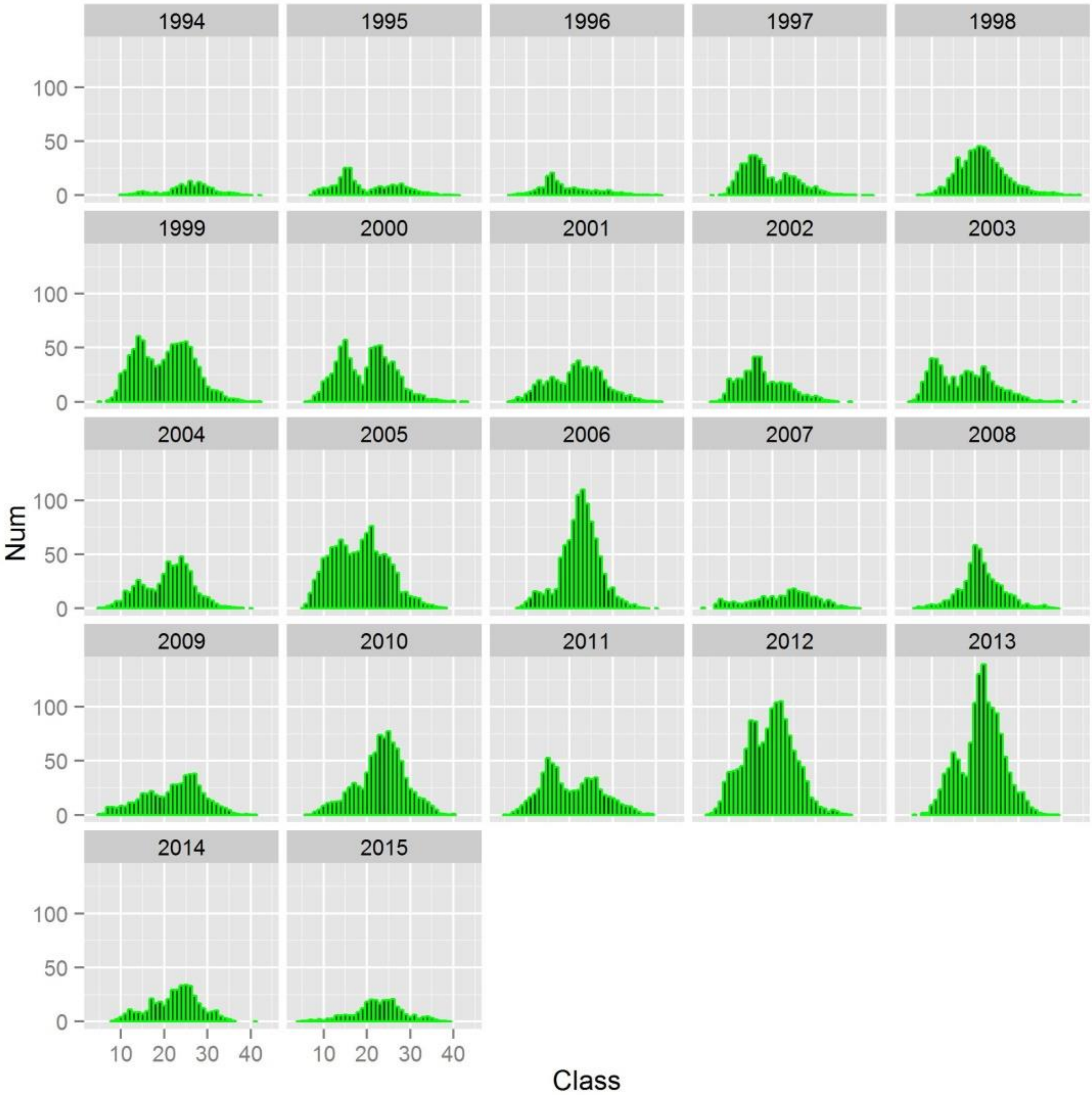


Figure 6.14.1.4.6. Deep-water rose shrimp in GSA 10. Stratified abundance indices by size (mm), 1994-2014.

6.14.2 STOCK ASSESSMENT ON DEEP-WATER ROSE SHRIMP IN GSA 10

Method 1- XSA

Stock assessment has been conducted using XSA method. The Extended Survivors Analysis (XSA – Darby and Flatman, 1994) has been used with an age range from 0 to 3+. Discards were included in the analysis. Since no discard data were available for 2004-2005 and 2007-2008, an estimate based on the average discard ratios and discard age structures of the available nearest years (2006, 2009-2011) has been used.

Input data

For the assessment of deep-water rose shrimp in GSA 10 the DCF official data on the age structure has been used. The numbers at age were estimated using the LFDA slicing method with sex separated parameters (Table 6.14.1.1-2). No SOP correction has been applied as differences were around 4.5% (average on 2004-2015) and ranged between 0.7% (2011) and 9.2% (2006). A sex-combined analysis was carried out.

The survey indices from MEDITS data from 2004 to 2015 have been used for the tuning. The age distribution of catches is showed in Figure 6.14.2-1 and Table 6.14.2-1. The age distribution of the tuning indices (from MEDITS survey) is reported in the Figure 6.14.2-2 and in the Table 6.14.2-2.

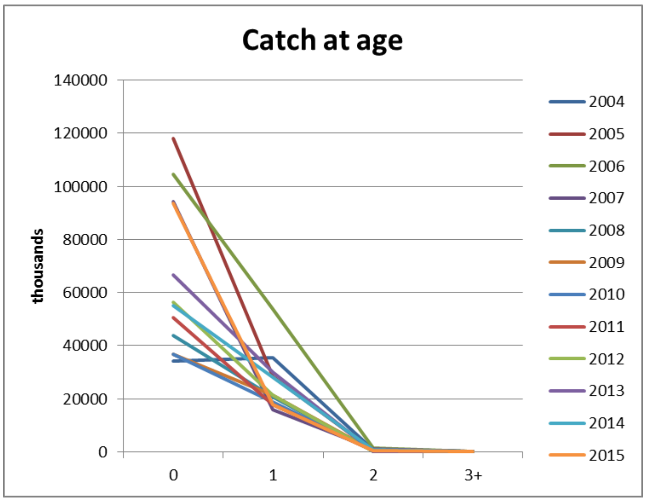


Figure 6.14.2.1. Deep-water rose shrimp in GSA 10. Age frequency distribution of the total catch (landings + discard), 2004-2015.

Table 6.14.2.1. Deep-water rose shrimp in GSA 10. Age frequency distribution of the total catch (landings + discard), 2004-2015.

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
0	34212	117968	104647	94380	43768	36865	36746	50686	56509	66703	55029	93574
1	35562	28260	53918	15897	20582	21409	18727	17949	21276	30173	28043	17970
2	638	405	1570	1157	328	488	561	470	256	146	878	362
3+	0	24	0	16	3	0.3	3	0	34	1	9	0

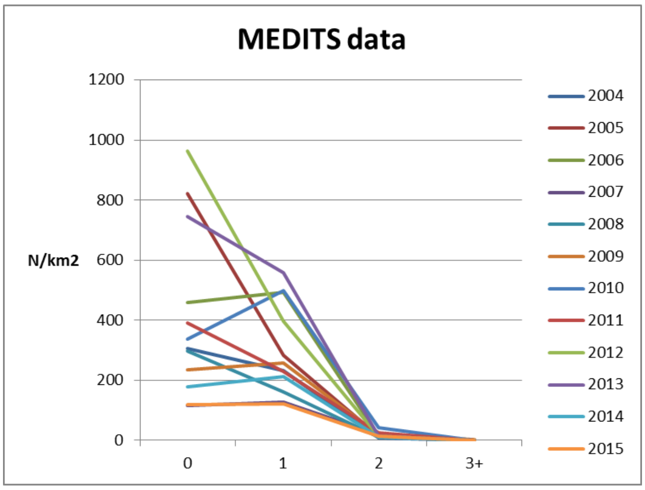


Figure 6.14.2.2. Deep-water rose shrimp in GSA 10. Age frequency distribution of the population (MEDITS data) 2004 -2015 used for tuning.

Table 6.14.2.2. Deep-water rose shrimp in GSA 10. Age frequency distribution of the population (MEDITS data), 2004-2015 used for tuning.

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
0	305.42	821.67	458.23	117.27	297.47	236.04	338.31	390.59	964.18	744.92	177.75	118.03
1	233.13	283.46	494.46	128.26	160.07	256.79	499.94	230.06	395.94	557.65	212.06	122.34
2	7.80	14.42	14.04	18.67	10.70	20.95	42.06	26.13	13.13	14.14	10.45	14.44
3+	0.30	0.13	0.21	0.74	0.55	1.26	1.16	1.00	0.05	0.20	0.14	0.31

Growth parameters, maturity and natural mortality vectors used for this assessment are reported in the Tables 6.14.1.1-2, 6.14.1.1-2 and 6.14.1.1-3.

In the Table below are reported the mean individual weights at age used for the catches calculated as weighted mean of the individual weight at age from DCF weighted by the number in each age class.

Table 6.14.2.3. Deep-water rose shrimp in GSA 10. Weights at age (kg) used in the XSA (used for the catch).

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015

0	0.005	0.004	0.006	0.004	0.005	0.005	0.005	0.004	0.005	0.005	0.004	0.004
1	0.011	0.010	0.010	0.011	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
2	0.021	0.021	0.020	0.020	0.020	0.020	0.019	0.021	0.021	0.019	0.019	0.020
3	0.031	0.031	0.027	0.023	0.019	0.027	0.027	0.027	0.027	0.026	0.027	0.027

In the Table below are reported the mean individual weights used for the stock calculated by means of length-weight relationship (using a and b parameters from DCF) and lengths at the beginning of the age classes (as the calculation of the SSB in XSA is at the beginning of the year) estimated with the growth parameters.

Table 6.14.2.4. Deep-water rose shrimp in GSA 10. Weights at age (kg) used in the XSA (used for the stock).

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
0	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003	0.0002	0.0002	0.0002
1	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
2	0.017	0.017	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.015	0.016
3	0.024	0.024	0.022	0.022	0.022	0.023	0.023	0.023	0.022	0.023	0.021	0.023

Results

From a first sensitivity analysis on the runs performed varying the shk.yrs and shk.ages options considering the log-catchability residuals and the retrospective, for the following runs of XSA the following settings have been chosen:

- Proportion of F before spawning = 0
- Proportion of M before spawning = 0
- Minimum standard error (mse) for population estimates derived from each fleet = 0.3.
- shk.n=TRUE, shk.f=TRUE, shk.yrs=3, shk.ages=3

A sensitivity analysis with two different hypothesis of natural mortality (PRODBIOM and Chen and Watanabe method) has been carried out. In figure 6.14.2-3 and Table 6.14.2-5 the two natural mortality vector used for sensitivity are reported.

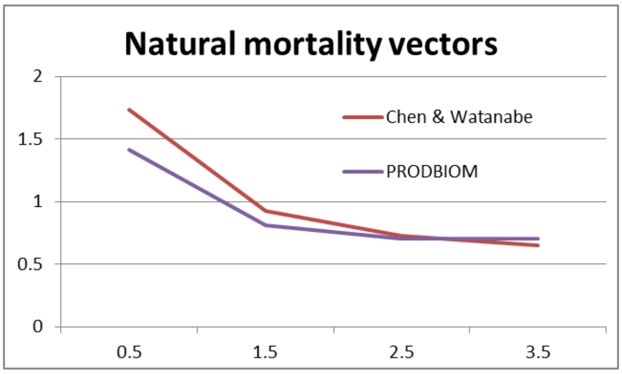


Figure 6.14.2.3. Deep-water rose shrimp in GSA 10. Natural mortality vectors used for sensitivity analysis.

Table 6.14.2.5. Deep-water rose shrimp in GSA 10. Natural mortality vectors used for sensitivity analysis.

age	Chen & Watanabe	PRODBIOM
0.5	1.74	1.41
1.5	0.92	0.81
2.5	0.73	0.7
3.5	0.65	0.7

Also a sensitivity analysis has been performed varying the following XSA settings:

- Catchability (rAGE) independent on stock size (values -1 and 0)
- Catchability (qAGE) independent of age (values 1 and 2)
- Shrinkage of the mean (FSE) (values 0.5, 1, 1.5, 2)

Table 6.14.2.5. Deep-water rose shrimp in GSA 10. Residual values (min, max and average and median in absolute value) in the 16 XSA performed runs.

run	rAGES	qAGES	FSE	shk_yrs	shk_ages	minimum	maximux	average abs_values	median abs_values
RUN n.9	-1	2	0.5	3	3	-1.14	1.07	0.51	0.44
RUN n.1	-1	1	0.5	3	3	-1.10	1.07	0.51	0.43
RUN n.13	0	2	0.5	3	3	-1.53	1.19	0.57	0.50
RUN n.5	0	1	0.5	3	3	-1.53	1.19	0.57	0.49
RUN n.2	-1	1	1	3	3	-1.06	1.02	0.46	0.41
RUN n.10	-1	2	1	3	3	-1.06	1.03	0.46	0.45
RUN n.6	0	1	1	3	3	-1.24	1.02	0.49	0.43
RUN n.14	0	2	1	3	3	-1.24	1.03	0.49	0.44
RUN n.11	-1	2	1.5	3	3	-1.09	0.85	0.31	0.24
RUN n.3	-1	1	1.5	3	3	-1.08	0.87	0.32	0.26
RUN n.15	0	2	1.5	3	3	-1.15	0.93	0.34	0.26
RUN n.7	0	1	1.5	3	3	-1.15	0.93	0.35	0.27
RUN n.12	-1	2	2	3	3	-1.10	0.80	0.28	0.20
RUN n.4	-1	1	2	3	3	-1.10	0.85	0.30	0.23
RUN n.16	**0**	**2**	**2**	**3**	**3**	**-1.12**	**0.92**	**0.31**	**0.20**
RUN n.8	0	1	2	3	3	-1.13	0.92	0.33	0.25

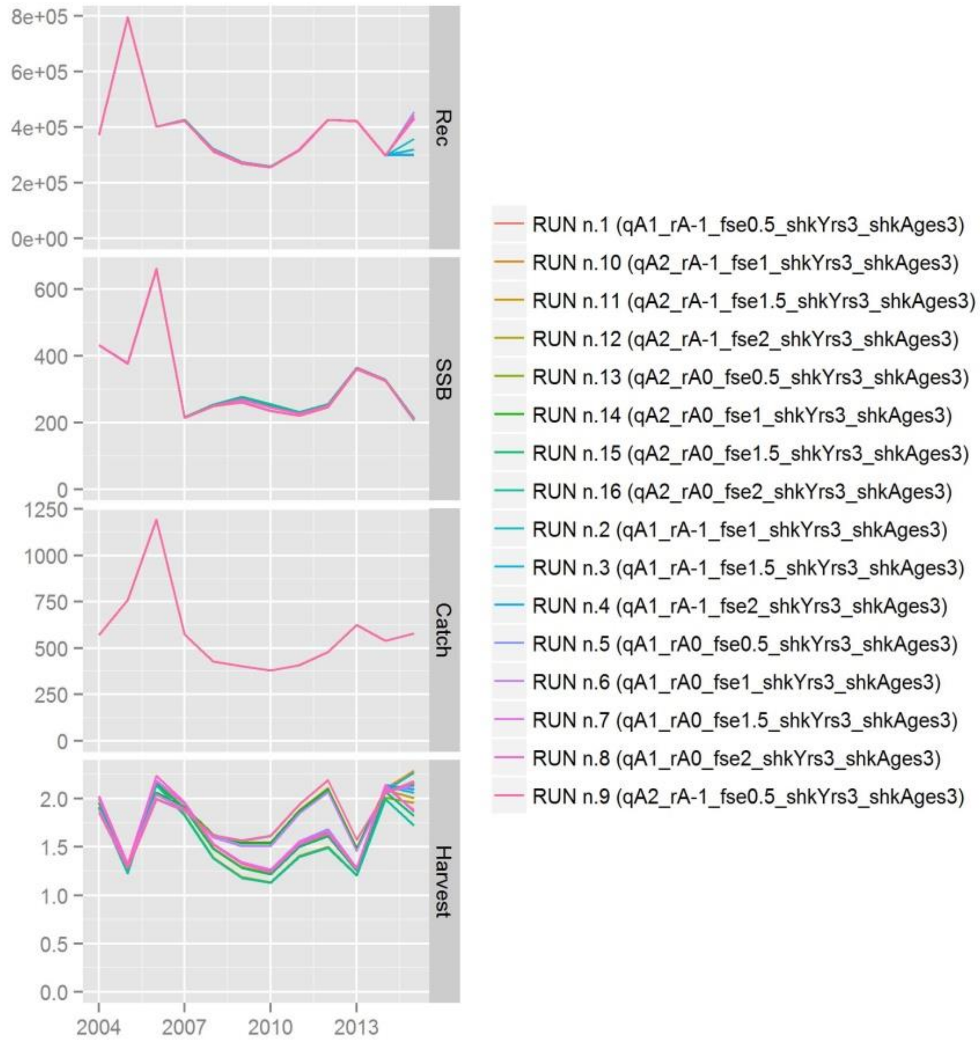


Figure 6.14.2.4. Deep-water rose shrimp in GSA 10. Plot of the stock parameters estimated in the 16 XSA runs.

Looking at the results from the sensitivity analysis two main trends (Figure 6.14.2-5) can be identified in the estimated harvests in the 16 XSA runs. Considering the period 2008-2014, the fishing mortality is higher with FSE=0.5 and FSE=1 than with the FSE=1.5 and FSE=2. The interpretation of this outcome is straightforward, considering that the higher FSE values give weight more the abundance indices from survey: the abundance trend generally show and increase until 2012, while catches are quite stable in the considered period.

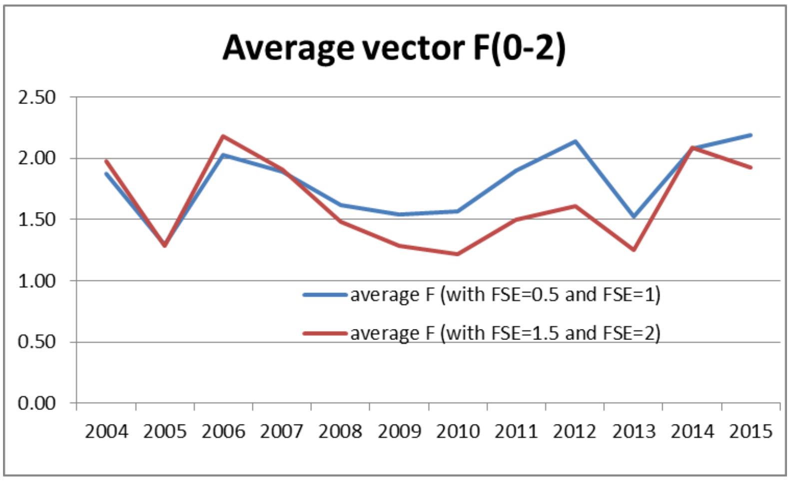


Figure 6.14.2.5. Deep-water rose shrimp in GSA 10. Plot of the fishing mortality averaged on the two set of the estimated fishing mortality in the 16 XSA runs.

The run n. 16 with catchability (rage) independent on stock size for all ages = 0, the catchability (qage) independent of age for ages > 2 and shrinkage of the mean (fse) = 2 has been chosen on the basis of the residuals (lowest median value) and of the retrospective analysis.

The chosen run has been performed with both natural mortality vectors (Table 6.14.2-5). The trends on fishing mortality, SSB and recruitment are reported in figure 6.14.2-6.

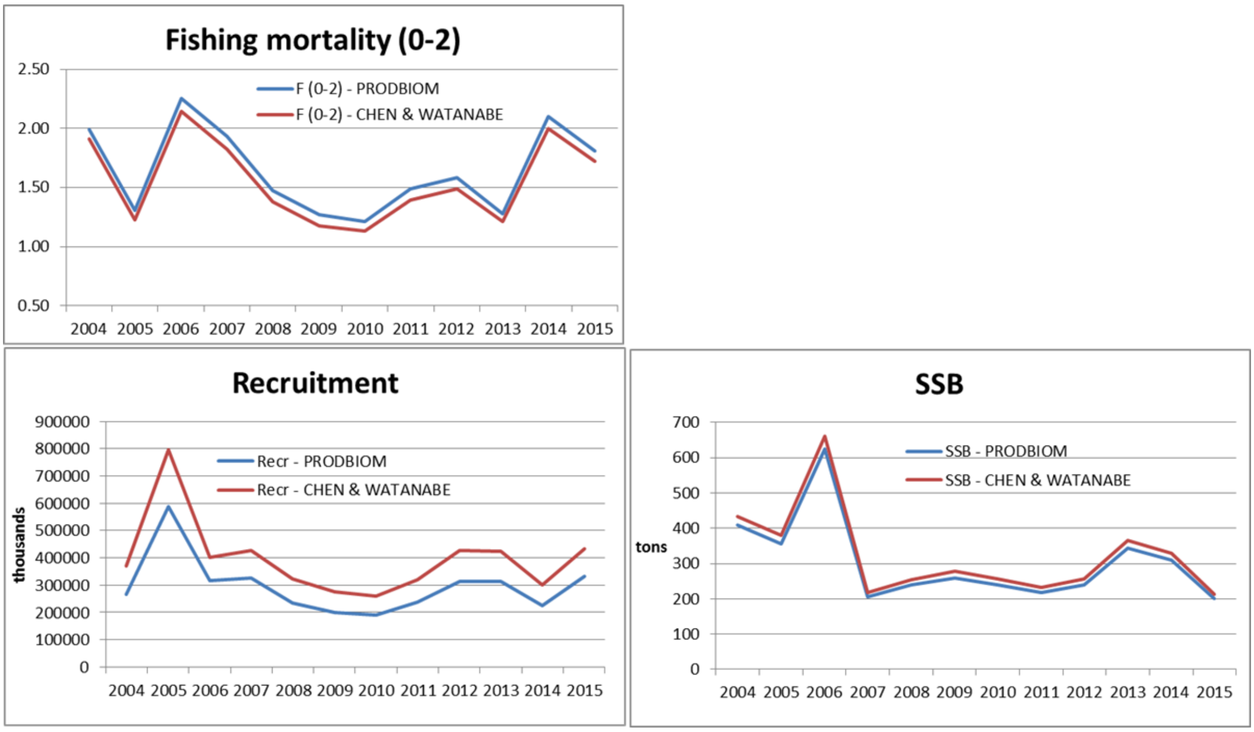


Figure 6.14.2.6. Deep-water rose shrimp in GSA 10. Trends of fishing mortality, recruitment and spawning stock biomass from XSA runs with the two natural mortality vectors (PRODBIOM and Chen & Watanabe).

Looking at the residuals the run performed with Chen & Watanabe shows slightly better results and the retrospective shows similar good results. The current F and RPs calculated with FLBRP packages for the two different runs are reported in Table 6.14.2-6 and figure 6.14.2-7.

Table 6.14.2.6. Deep-water rose shrimp in GSA 10. Results of sensitivity analysis on natural mortality vectors.

	Prodbiom	Chen & Watanabe
F (2015)	1.81	1.72
F 0.1	0.93	1.2
F(2015)/F0.1	**1.9**	**1.4**

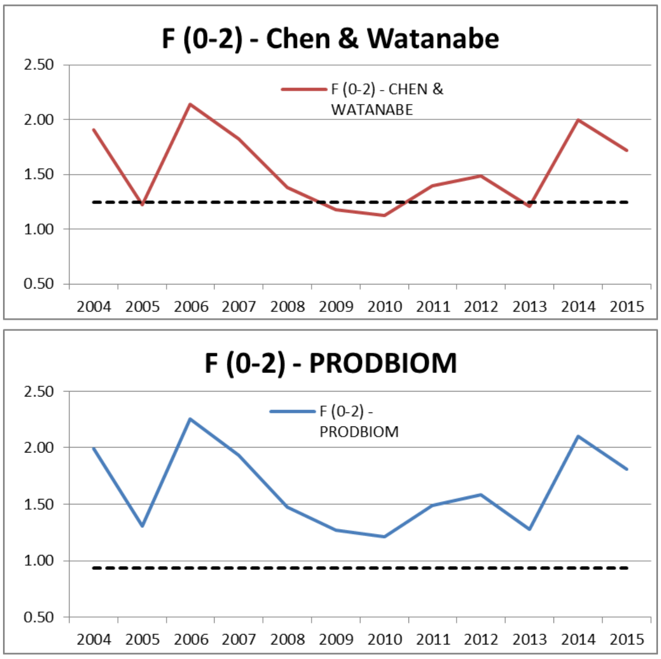


Figure 6.14.2.7. Deep-water rose shrimp in GSA 10. Trends of fishing mortality with the two natural mortality vectors (PRODBIOM and Chen & Watanabe). Dotted black lines represent the reference points.

Using both PRODBIOM and Chen & Watanabe mortality vectors the results show that the stock is overexploited being the current F above the RPs (the ratio Fcurrent/F0.1 is respectively 1.9 and 1.4).

The experts of the EWG 16-17 agreed that there is no technical basis to choose between the two natural mortalities used in the analysis, considering that the residuals and retrospectives did not give a clear signal that one run was better than the other one. In order to be in line with the previous assessment (EWG 13-09) and the present assessments of the same species in other contiguous areas (GSA 9 and 11), the mortality vector chosen for the final run has been PRODBIOM.

The log-catchability residuals at age for the tuning index are reported in figure 6.14.2-8.

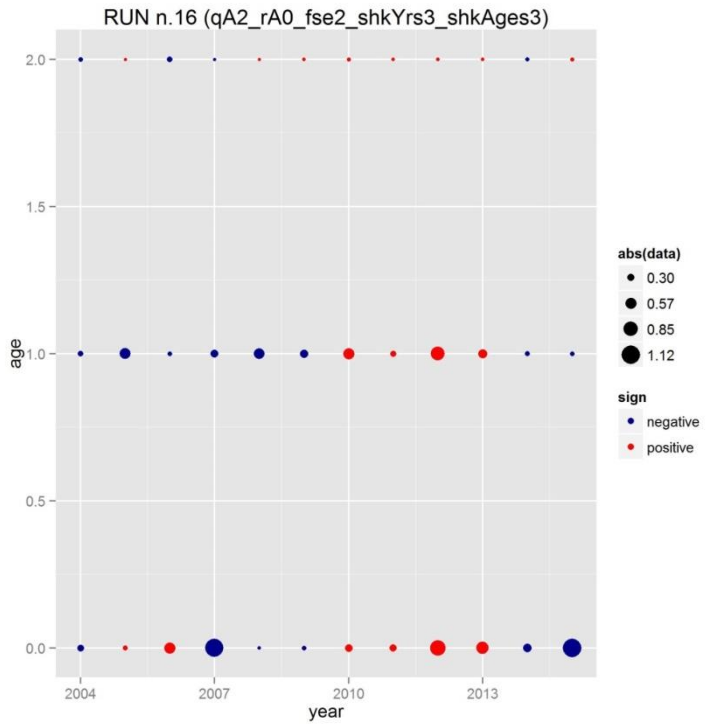


Figure 6.14.2.8. Deep-water rose shrimp in GSA 10. Log-catchability residuals at age for the tuning index.

The residuals do not show any trend and overall the absolute values are low. The retrospective analysis also shows a very consistent pattern (Figure 6.14.2-9).

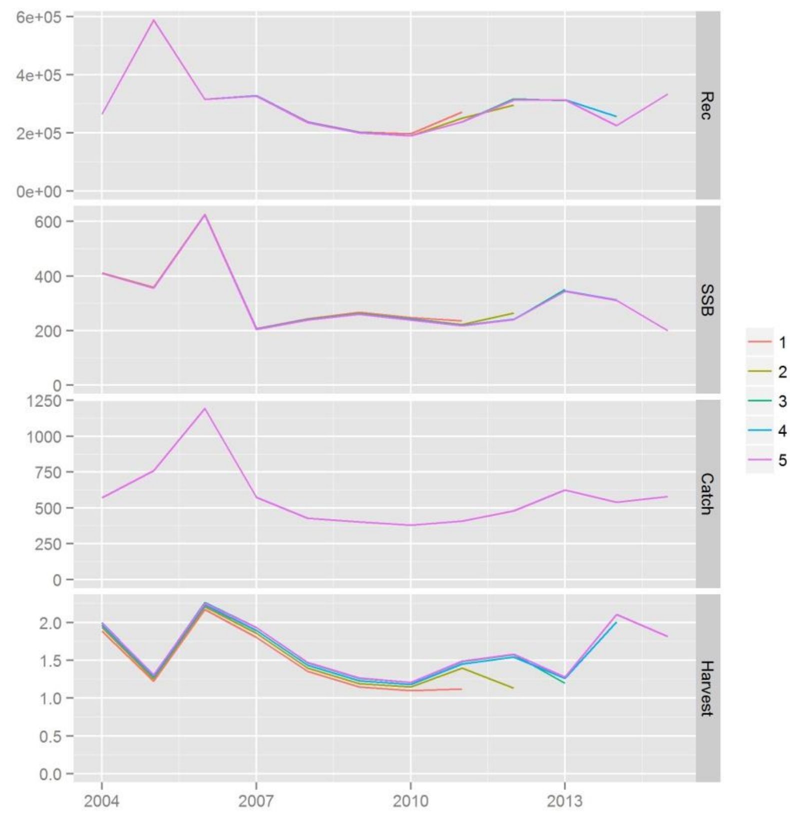


Figure 6.14.2.9. Deep-water rose shrimp in GSA 10. Retrospective analysis (2011-2015).

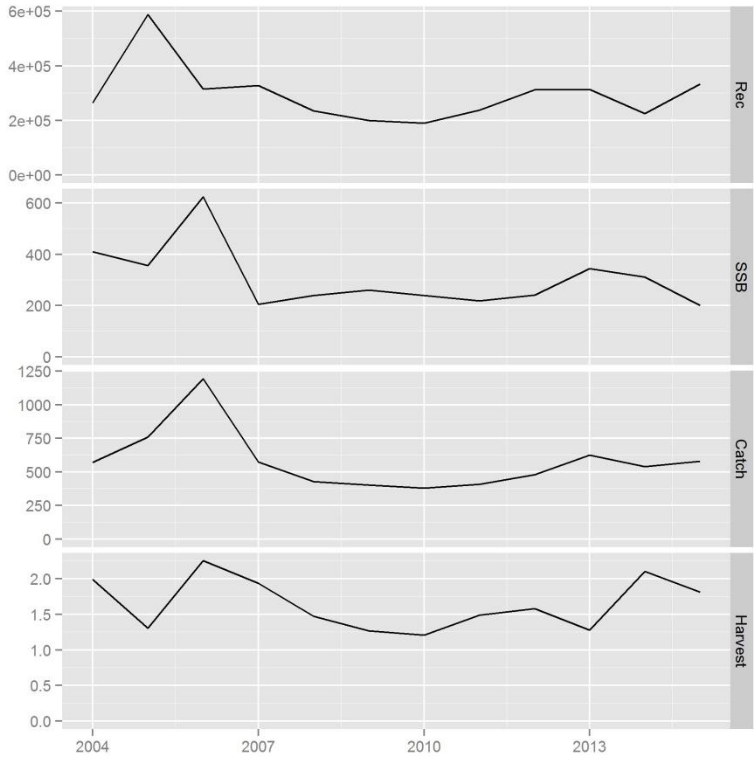


Figure 6.14.2.10. Deep-water rose shrimp in GSA 10. XSA results in terms of recruitment, SSB, Catches and fishing mortality.

The recruitment shows a peak in 2005 equal to 587188 thousands individuals and after that year decreases until 2010 (190121 thousands) and then increase again until 2012 when reach an average value (2012-2015) of about 296297 thousands. The SSB shows a decreasing trend after the main peak in 2006 (624 t) remaining quite stable for the following years on an average value (2007-2011) of about 232 t until 2013 when the value of the SSB is the highest value among the more recent years. In the last two years the SSB decreases reaching the lower value of the time series (201 t).

Table 6.14.2.7. Deep-water rose shrimp in GSA 10. Fishing mortality at age by year, $F_{bar(0-2)}$, spawning stock biomass (SSB, t) and Recruitment (R, thousands) estimated with XSA.

age	0	1	2	3+	Fbar (0-2)	SSB (t)	R (thousands)
2004	0.30	3.40	2.28	2.28	1.99	410	264866
2005	0.52	2.18	1.21	1.21	1.30	356	587188
2006	1.11	3.00	2.64	2.64	2.25	624	315289
2007	0.88	2.87	2.06	2.06	1.94	205	327158
2008	0.47	2.64	1.31	1.31	1.47	239	235104
2009	0.47	2.28	1.06	1.06	1.27	260	200298
2010	0.50	2.46	0.67	0.67	1.21	239	190121
2011	0.56	3.04	0.86	0.86	1.49	219	237931
2012	0.46	3.36	0.93	0.93	1.58	240	312310
2013	0.56	2.75	0.52	0.52	1.28	344	314097
2014	0.68	3.26	2.37	2.37	2.10	311	225412

age	0	1	2	3+	Fbar (0-2)	SSB (t)	R (thousands)
2015	0.84	3.43	1.16	1.16	1.81	201	333369

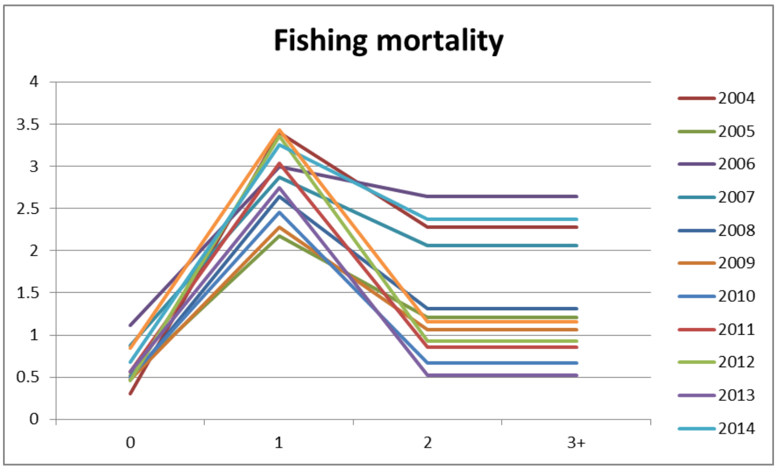


Figure 6.14.2.11. Deep-water rose shrimp in GSA 10. Fishing mortality at age by year estimated with XSA.

Method 2. Length-based analysis

Length-based methods were used for deriving some indicators explored in WKLIFE IV. (ICES, 2015). They allow classifying the stocks according to conservation/sustainability, yield optimization and MSY considerations. Analysis required data on the stock catch/landings–length composition and life-history parameters as Linf.

The length-based indicators analysis was performed using the commercial landings in 2004 to 2015 (discards considered negligible) and the following life-history parameters: Linf = 43 mm.

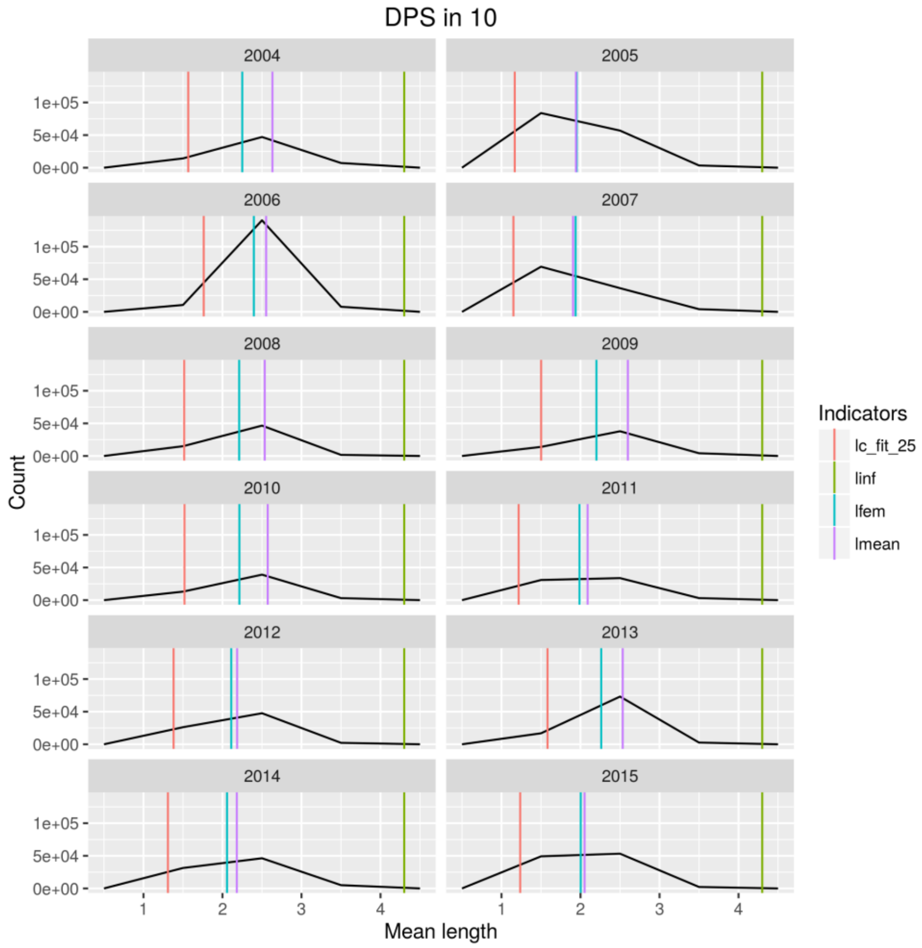


Figure 6.14.2.12. Deep-water rose shrimp in GSA 10. Length-based indicators and reference points for rose shrimp using the catch length composition for 2004, to 2015

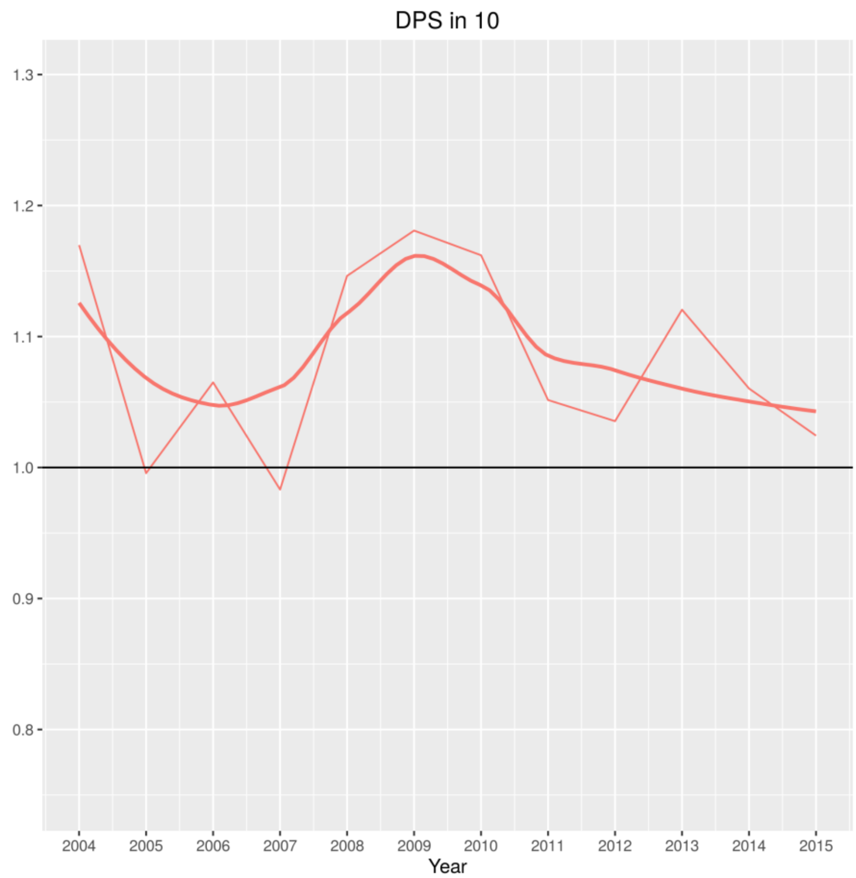


Figure 6.14.2.13. Deep-water rose shrimp in GSA 10. Length-based indicator for rose shrimp using the catch length composition for 2004 to 2015

The overall perception from length-based indicators is that the stock is being fished just below MSY level. The XSA assessment supports a higher exploitation rate than this simple length indicator assessment; this may be due to the difference in definition of FMSY proxy as F0.1 is chosen to be more precautionary than the assessment using the length indicator. The indicator also supports the view of decreasing F in the middle of the period evaluated with rising F in the later years.

6.14.3 REFERENCE POINT

Method

The time series of SSB and R values is not sufficient to allow evaluation of S-R elements of MSY, so the WG has applied the STECF recommended method of F0.1. To predict the effect of changes in fishing effort of future yields and to define reference points F_{01} (as a proxy for F_{MSY}) and F_{max} a Yield per Recruit analysis (YPR) was carried out in R using FLBRP FLR package (https://cran.r-project.org/web/packages/FLR/index.html).

Input data

As input the same 3 year average weight maturity and natural mortality parameters used for the XSA and its output of the exploitation pattern were used were for the YPR evaluation.

Results

The reference points calculated with FLBRP package are shown in Table 6.14.3.1.

Table 6.14.3.1. Deep-water rose shrimp in GSA 10. Reference Points estimated on the Fbar(0-2) using XSA.

F	Total Yield	Recruitment	SSB	Biomass
0.94	438	55796	1440	1623

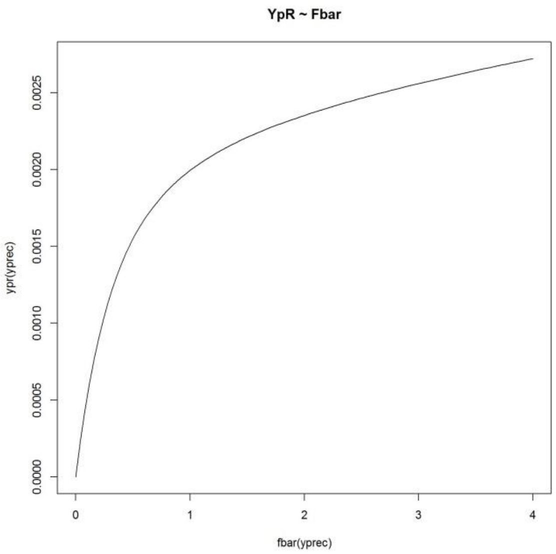


Figure 6.14.3.1. Deep-water rose shrimp in GSA 10. Yield per Recruitment, XSA.

6.14.4 SHORT TERM FORECAST

Method

A deterministic short term prediction for the period 2016 to 2018 was performed using the FLR routines (stf.r script made available to the working group) provided by JRC, which takes into account the catch and landings in numbers and weight and the discards. This routine performs short terms for the whole fleet.

Input parameters

The same input parameters used in the XSA analysis shown above were used. Different scenarios of constant harvest strategy with F_{bar} calculated as the average of ages 0 to 2 and F status quo (F_{stq} = 1.7; geometric mean of the last three years 2013-2015) were performed. Recruitment (class 0) has been estimated from the population results from the geometric mean of the last three years 2013-2015 (286850 thousands individuals) estimated using XSA.

Results

The results of the short term forecasts related to the trawlers fleet in GSA 10 are summarized in the Table 6.14.4.1.

Table 6.14.4.1. Deep-water rose shrimp in GSA 10. Short term forecast in different F scenarios computed for deep-water rose shrimp in GSA 10. Basis: weight, maturity and natural mortality and selection are 3 years averages (2013-2015), F(2016) = mean(F_{bar}0-2 2013-2015)= 1.7; R(2016) = geometric mean of the recruitment of the last three years = 286850 (thousands); SSB(2015) = 200 t, Catch (2015)= 578 t.

Rationale	Ffactor	Fbar	Catch 2017	Catch 2018	SSB 2018	Change SSB 2017-2018(%)	Change Catch 2015-2017(%)
zero catch	0	0	0	0	730	189	-100
High long-term yield (F0.1)	0.53	0.9	438	536	382	51	-24
Status quo	1	1.7	648	648	254	0.3	12
Different scenarios	0.1	0.17	112	186	632	150	-81
	0.2	0.34	207	316	554	119	-64
	0.3	0.51	288	408	490	94	-50
	0.4	0.68	358	475	438	73	-38
	0.5	0.85	420	524	394	56	-27
	0.6	1.02	475	561	358	41	-18
	0.7	1.19	525	590	326	29	-9
	0.8	1.36	569	613	299	18	-1.6
	0.9	1.53	610	632	275	9	5
	1.1	1.86	683	662	235	-7	18
	1.2	2.03	715	675	217	-14	24
	1.3	2.20	745	687	202	-20	29
	1.4	2.37	774	697	188	-26	34
	1.5	2.54	801	707	175	-31	38
	1.6	2.71	826	717	163	-36	43
	1.7	2.88	850	726	152	-40	47
	1.8	3.05	872	734	141	-44	51
	1.9	3.22	894	743	132	-48	54
	2	3.39	914	751	123	-51	58

A short term projection of the trawlers fleet (Table 6.14.4.1), assuming an Fstq of 1.7 in 2015 and a recruitment of 286850 thousands individuals (geometric mean on last 3 years) shows that:

- Fishing at the Fstq (1.7) generates an increase of the catch of 12% from 2015 to 2017 along with an approximately stable spawning stock biomass (change 0.3%) from 2017 to 2018.
- Fishing at F0.1 (0.9) generates a decrease of the catch of 24% from 2015 to 2017 and an increase of the spawning stock biomass of 51% from 2017 to 2018.

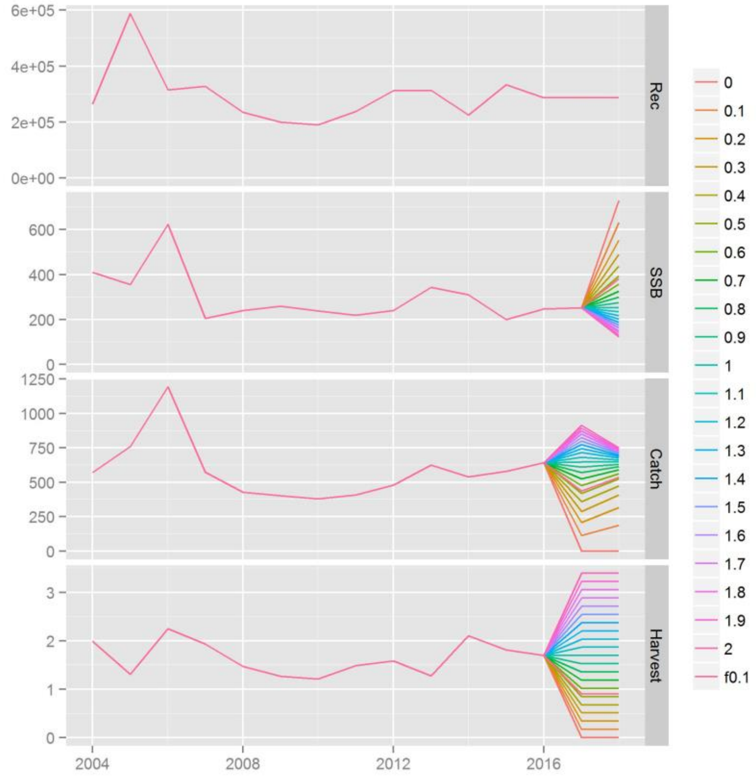


Figure 6.14.4.1. Short term forecast in different F scenarios computed for deep-water rose shrimp in GSA 10. Basis: F(2016) = mean(F_{bar}0-2 2013-2015)= 1.7; R(2016) = geometric mean of the recruitment of the last three years = 286850 (thousands); SSB(2015) = 200 t, Catch (2015)= 578 t.

6.14.5 QUALITY AND PROPOSALS FOR FUTURE ASSESSMENTS

6.15 DEEP-WATER ROSE SHRIMP IN GSAs 9,10 AND 11

6.15.1 DATA GATHERING OF DEEP-WATER ROSE SHRIMP IN GSAs 9,10 AND 11

6.15.1.1 Stock Identity and Biology

GSAs 9, 10 and 11 belong to the FAO Division 37.1.3 (Sardinia). There are not many studies regarding the presence of a unique stock or the presence of different sub populations of deep-water rose shrimp in the three GSAs. The information available has been recently analysed in the context of Stockmed project. According to the results of Stockmed project, deep-water rose shrimp of GSA 09 is part of the stock that includes many GSAs of western Mediterranean (GSA 1, GSAs 5-8, GSA 11), while the species in GSA 10 shows characteristics more similar to those observed in GSAs 16 and 19. However, the analyses underlined that the characteristics of the specimens living in the southern part of GSA 9 (northern Tyrrhenian Sea) are more similar to those of GSA 10. In particular, the analysis of recurrent nursery or spawning grounds imply an increased probability that GSAs 9 and 10 are inhabited by the same stock. It would appear that the GSA 9 is a transitional zone with different environmental characteristics. However, it should be noted that, in recent years, deep-water rose shrimp is also significantly increased in the northern part of GSA 9 (Ligurian Sea) making the GSA more homogeneous with regard to the distribution and abundance of the species. Deep-water rose shrimp is a thermophilic species and the expansion to the north of its distribution may be the direct result of global warming. The same phenomenon has been observed simultaneously along the Spanish Mediterranean coasts.

Concerning GSA 11, Stockmed project indicated that the population around Sardinia Island shows characteristics more similar to those distributed in the western part of the Mediterranean.

The present assessment was performed combining the data coming from GSAs 9, 10 and 11.

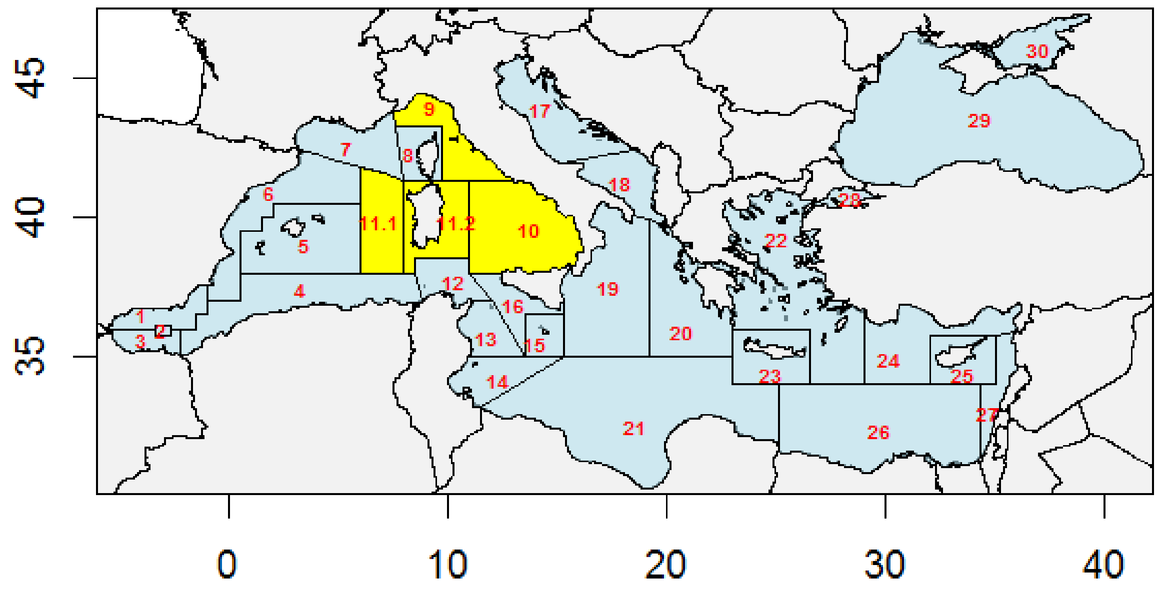


Figure 6.15.1.1.1 Geographical location of GSAs 9, 10 and 11.

6.15.1.1.1 Growth

Different sets of growth parameters have been reported in the DCF database. In GSAs 9 and 10 growth curves by sex are available, while in GSA 11 a combined curve is furnished. Similar pattern was observed considering the parameters for females and combined sex. The main differences are between the two curves for males. The size frequency distributions have been sliced using different growth parameters according to the different GSAs.

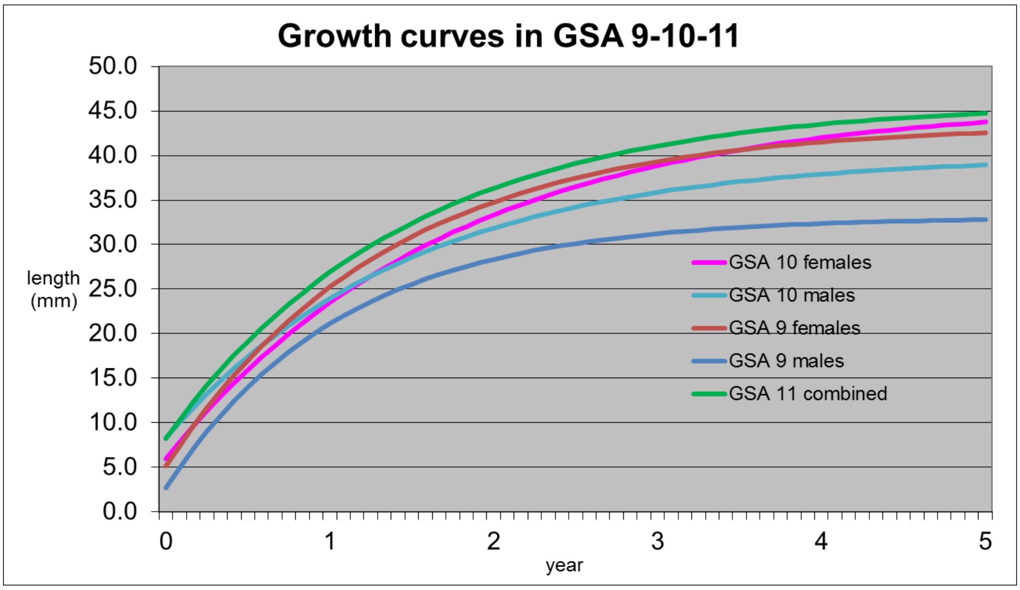


Figure 6.15.1.1.1.1 Deep-water rose shrimp in GSAs 9, 10 and 11. Von Bertalanffy curves used in the analysis.

Table 6.15.1.1.1.1 Deep-water rose shrimp in GSAs 9, 10 and 11. Von Bertalanffy growth parameters used in the analysis.

		GSA9	GSA10	GSA11
Females	L_{inf}	43.5	46.0	
	K	0.74	0.575	
	T_0	-0.13	-0.20	
Males	L_{inf}	33.1	40.0	
	K	0.93	0.68	
	T_0	-0.05	-0.25	
Combined	L_{inf}			46.0
	K			0.68
	T_0			-0.25

6.15.1.1.2 Maturity

Vectors of sexual maturity by age class and year have been computed as weighed means of the vectors available for the three different GSAs.

Table 6.15.1.1.2.1 Deep-water rose shrimp in GSAs 9, 10 and 11. Vector of sexual maturity by age and year.

	Age 0	Age 1	Age 2	Age 3+
2006	0.03	0.93	1	1
2007	0.02	0.91	1	1
2008	0.02	0.90	1	1
2009	0.01	0.90	1	1

2010	0.02	0.86	1	1
2011	0.02	0.86	1	1
2012	0.02	0.86	1	1
2013	0.01	0.88	1	1
2014	0.01	0.88	1	1
2015	0.01	0.85	1	1

6.15.1.1.3 Natural mortality

Natural mortality was estimated using ProdBiom (Abella *et al*., 1997). A curve by sex has been estimated, and then a single M vector was produced combining the two vectors obtained by sex (weighed average by age class). The natural mortality vector by age is reported in Table 6.15.1.1.3.1.

Table 6.15.1.1.3.1. Deep-water rose shrimp in GSAs 9, 10 and 11. Vector of natural mortality by age.

Age	M
0	1.41
1	0.81
2	0.70
3+	0.70

6.15.1.2 Catch data

General description of the fisheries

A detailed description of the fisheries in GSA 09 and GSA 10 are reported in the single assessments (Paragraphs 6.13.1.2.1 and 6.14.1.2.1).

In GSA 11 deep-water rose shrimp is one of the most important target species of the fishery carried out on bottoms of the upper slope and it is part of an important fishing assemblage targeted exclusively by trawlers of which as *Nephrops norvegicus*, *Merluccius merluccius*, *Eledone cirrhosa*, *Illex coindetii*, *Todaropsis eblanae*, *Helicolenus dactylopterus*, *Phycis blennoides*, *Micromesistius poutassou*, Lophius sp. are the most priceless species.

The large trawlers of GSA 11 operate all the week from Monday to Saturday, generally coming back daily to the closest port at the coast for few hours early in the morning in order to send all the fish to the market. The mid-sized and small trawlers perform daily fishing trips, before the sunrise until the early morning, staying sometimes two days at sea. Moreover, due to the distance of the fishing grounds (Murenu *et al*., 2010) to the main harbors of the western cost and the dominant weather conditions, the fleet targeting *P. longirostris* shows some seasonal variations, with more time spent at sea from mid spring to mid-autumn. Some large trawlers move seasonally to different fishing grounds far from the usual ports. Most of the effort in GSA 11 is concentrated around the major fishing ports (Cagliari, Alghero, Porto Torres, La Caletta, Sant'Antioco, Oristano, Alghero). The trawl fleet showed remarkable changes from 1994 to 2004, with a general increase in the number of vessels and the replacement of the older ones, low tonnage wooden boats by larger steel boats. At present, in the GSA 11 operate about 1300 boats, 150 of which are small medium and big trawlers. Administratively they all belong to the major fishing ports namely Cagliari, La Maddalena, Olbia, Oristano and Porto Torres. Other important ports are Alghero, Porto Torres, La Caletta and Sant'Antioco.

Landings

The annual total landing of deep-water rose shrimp observed from 2006 to 2015 is reported in Figure 6.15.1.2.2.1. The landing coming from GSA 11 resulted quite low along the time series in comparison with the other two GSAs. In the first years, the landing was higher in GSA 10, and then, since 2010, GSA 09 has become the most important in terms of biomass landed. The trend of the landing for the combined GSAs shows a significant decrease at the beginning of the series followed by some years of stability. Starting from 2010, a constant increase is observed until the maximum value registered in 2015.

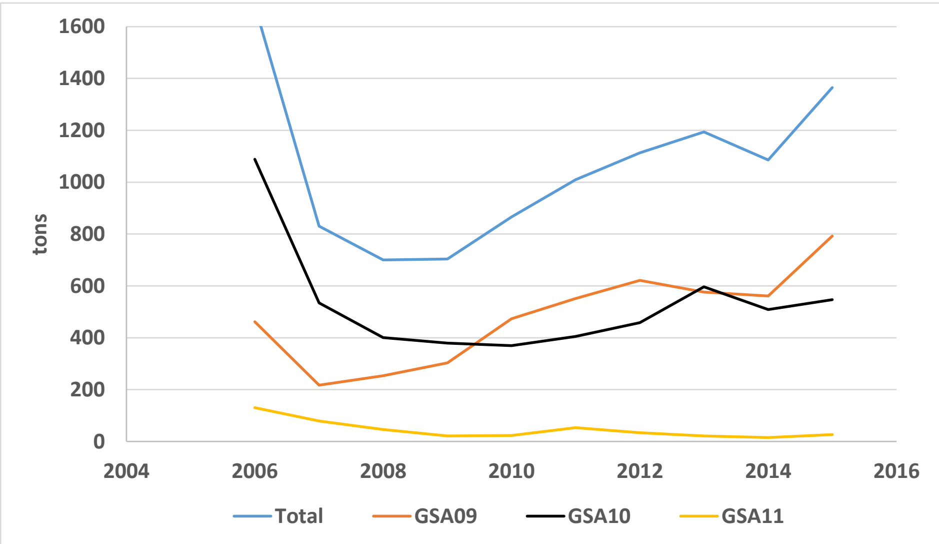


Figure 6.15.1.2.1 Deep-water rose shrimp in GSAs 9, 10 and 11. Annual landings from 2006 to 2015 by single and combined GSAs.

Table 6.15.1.2.1 Deep-water rose shrimp in GSAs 9, 10 and 11. Annual landings (t) by single and combined GSAs.

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
GSA9	462	217	254	303	473	551	621	576	561	792
GSA10	1089	534	400	379	370	405	459	597	509	547
GSA11	130	79	46	22	23	53	34	21	16	26
Total	1681	830	700	704	866	1009	1114	1194	1086	1365

Information on the demographic composition of the landing in GSA 09 and GSA 10 is reported in the single assessments.

For GSA 11, the size structures of the landing in DCR-DCF database are available for the period 2009-2015. The size distributions show that the most exploited sizes ranged from 18 to 35 mm CL (Figure 6.15.1.2.2). According to the growth pattern of the species, fishing exploits mainly 0 and 1 age classes.

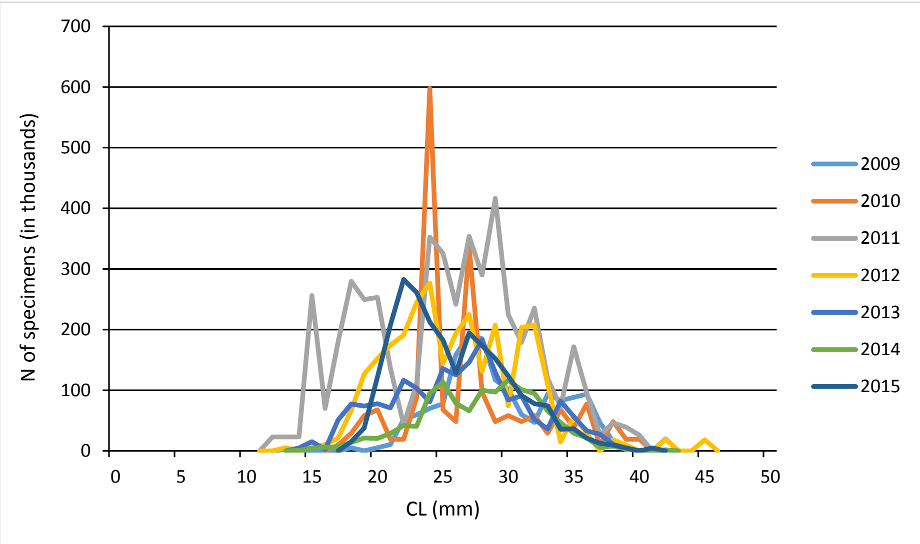


Figure 6.15.1.2.2 Deep-water rose shrimp in GSA 11. Size frequency distributions of the landing.

Discards

Detailed information on discards in GSAs 9 and 11 are reported in the single assessments. For GSA 11 there is no information in the DCR-DCF database.

Discard resulted notably higher in GSA 9. In the whole area the discarded biomass *of P. Longirostris* ranged from a minimum of 12 tons in 2012 to a maximum of 102 tons in 2015 (Table 6.15.1.2.3).

Table 6.15.1.2.2 Annual discard (t) for OTB in GSA 9 and GSA 10.

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
GSA9	34	35	41	49	27	63	8	30	45	89
GSA10	4	5	4	7	3	2	4	9	3	13
Total	38	40	45	56	30	65	12	39	48	102

6.15.1.3 Fishing effort data

The total fishing effort of the trawl fleets operating in the three GSAs, expressed as kw*days at sea, has shown a progressive decrease in the period 2004-2012. It varied from about 30,597,000 in 2004 to 19,694,000 in 2015. Anyway, there is no information on the specific effort directed to *P. longirostris*.

Table 6.15.1.3.1 Deep-water rose shrimp in GSAs 9, 10 and 11. Fishing effort expressed in kW*days (thousands) (Source: DCF database).

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
GSA09	14584	14671	14820	14701	12404	12782	10776	12173	11228	10696	9998	10725	10976	11095
GSA10	7344	7231	8070	8029	7501	7287	5725	5998	5603	5235	6051	6154	8797	5511
GSA11	3680	4653	7706	7325	5753	5868	4326	4371	4037	3788	3824	3139	3298	3088
Total	25607	26555	30597	30055	25658	25937	20827	22541	20868	19719	19873	20018	23071	19694

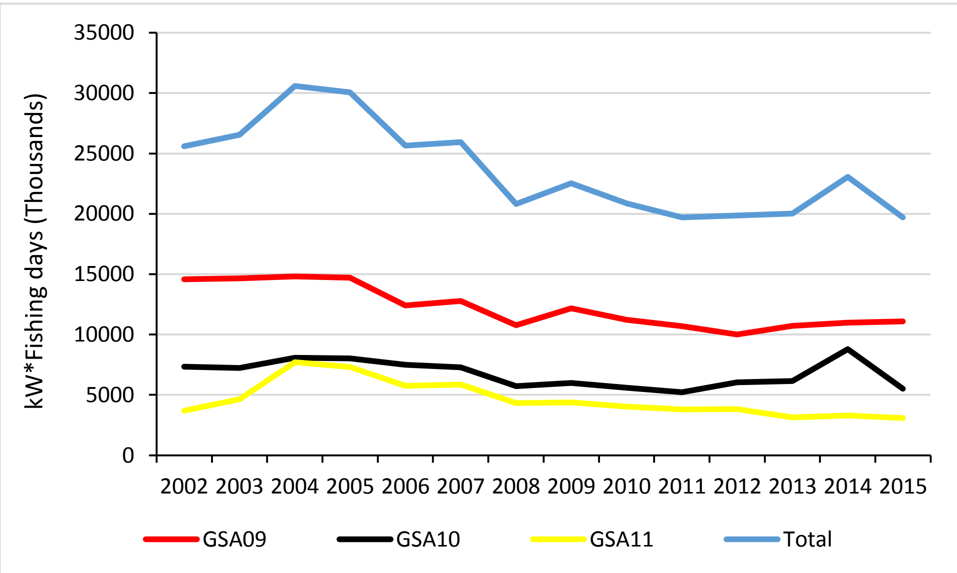


Figure 6.15.1.3.1 Deep-water rose shrimp in GSAs 9, 10 and 11. Fishing effort expressed in kW*days at sea.

6.15.1.4 Survey Indices of abundance and biomass by year and size/age

Survey #1 (MEDITS)

Methods

Since 1994 MEDITS trawl surveys has been regularly carried out each year (May-July). A random stratified sampling by depth (5 strata with depth limits at: 50, 100, 200, 500 and 800 m) was applied. Haul allocation was proportional to the stratum area. Detailed data on the gear characteristics, operational parameters and performance are reported in Fiorentini and Dremière (1996). Considering the small mesh size a complete retention was assumed. All the abundance data (number and total weight of fish per surface unit) were standardized to square kilometre using the swept area method. Based on the DCF data, abundance and biomass indices were recalculated.

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. Hauls noted as valid were used only, including stations with no catches of hake, red mullet or deep-water rose shrimp (zero catches are included).

The abundance and biomass indices by GSA were calculated through stratified means. This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$Yst = \Sigma (Yi*Ai) / A$

$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$

Where:

A=total survey area

Ai=area of the i-th stratum

si=standard deviation of the i-th stratum

ni=number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Yi=mean of the i-th stratum

Yst=stratified mean abundance

V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± t(student distribution) * V(Yst) / n

It was noted that while this is a standard approach, the calculation may be biased due to a number of different factors including the change in the number of hauls over time, and change of the survey time over the years. Precision may also be affected by the choice of parametric distribution, a normal distribution is often assumed, whereas data may be better described by a delta-distribution, quasi-Poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien *et al.* 2004).

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance*100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA.

Geographical distribution

The following maps show the abundance (in biomass) per haul of the MEDITS survey standardized to square kilometer. It is evident as in the first years the abundance of deep-water rose shrimp was low in particular in the northern part of GSA 09. Since 1998 the abundance of the species increased in the north-central Tyrrhenian Sea and along the south-western coasts of Sardinia. Since 2015, very high indices were observed for GSA 09 including the northern part.

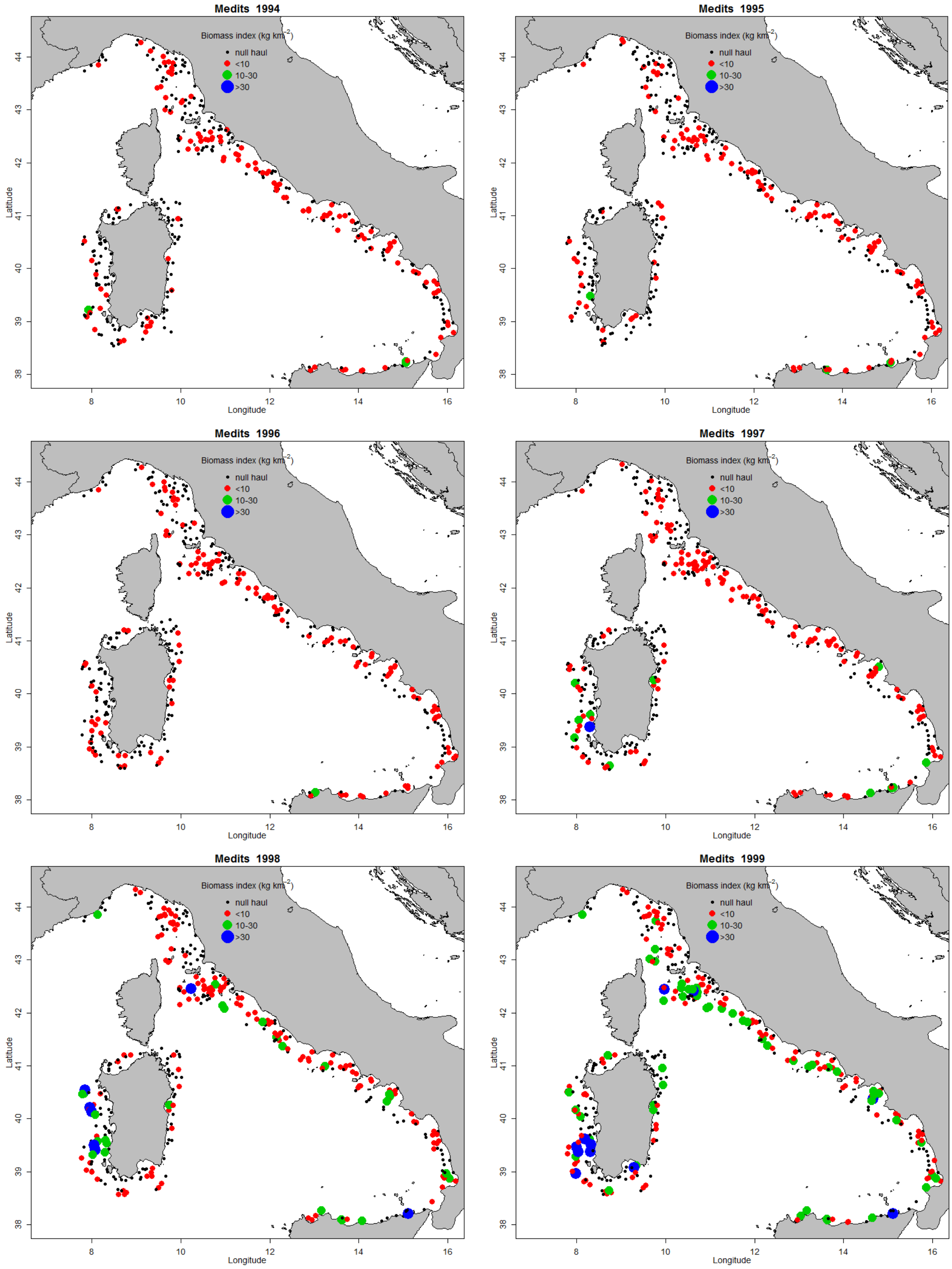


Figure 6.15.1.4.1 Deep-water rose shrimp in GSAs 9, 10 and 11. Distribution pattern in the period 1994-1999 (MEDITS survey).

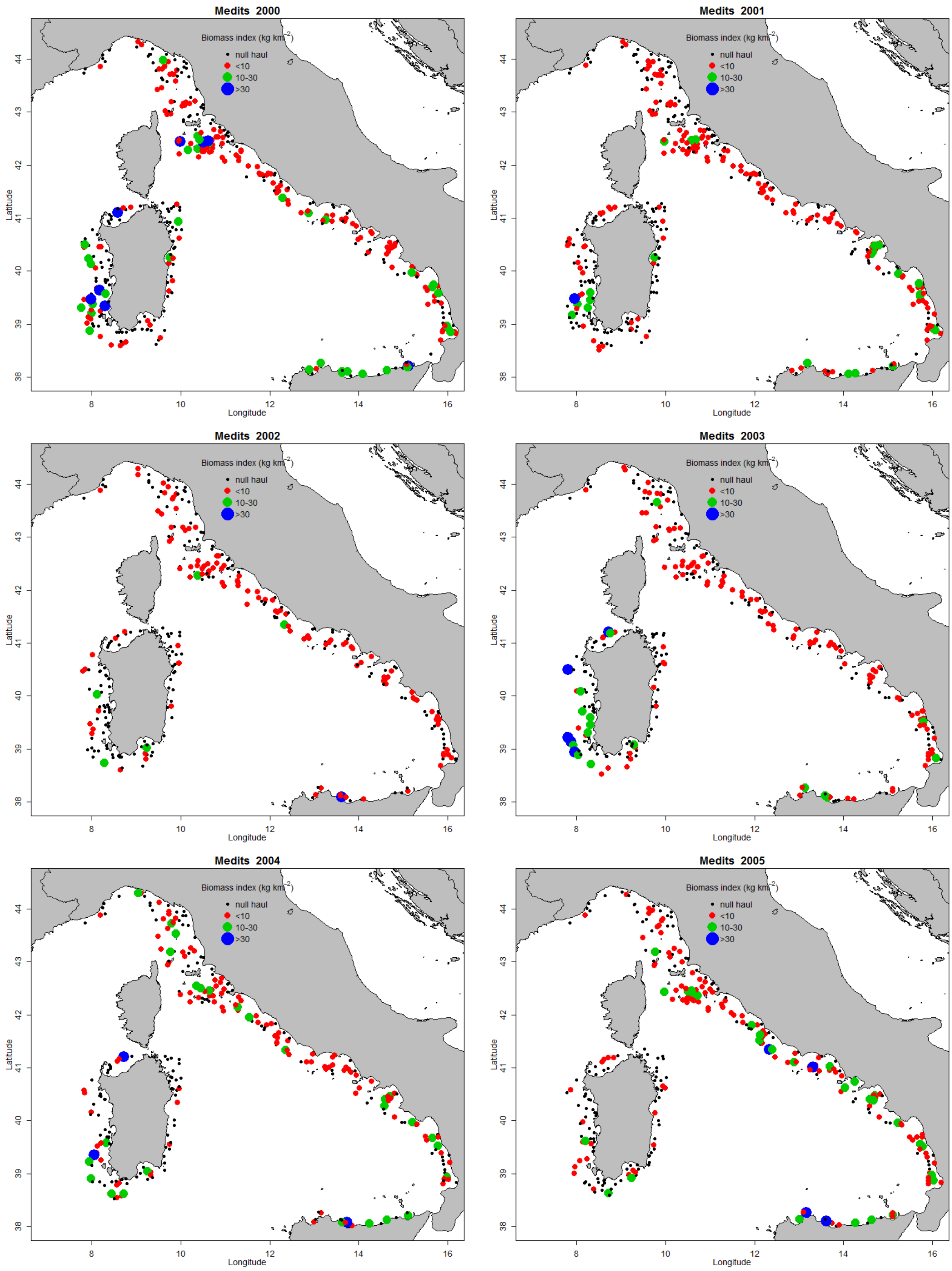


Figure 6.15.1.4.2 Deep-water rose shrimp in GSAs 9, 10 and 11. Distribution pattern in the period 2000-2005 (MEDITS survey).

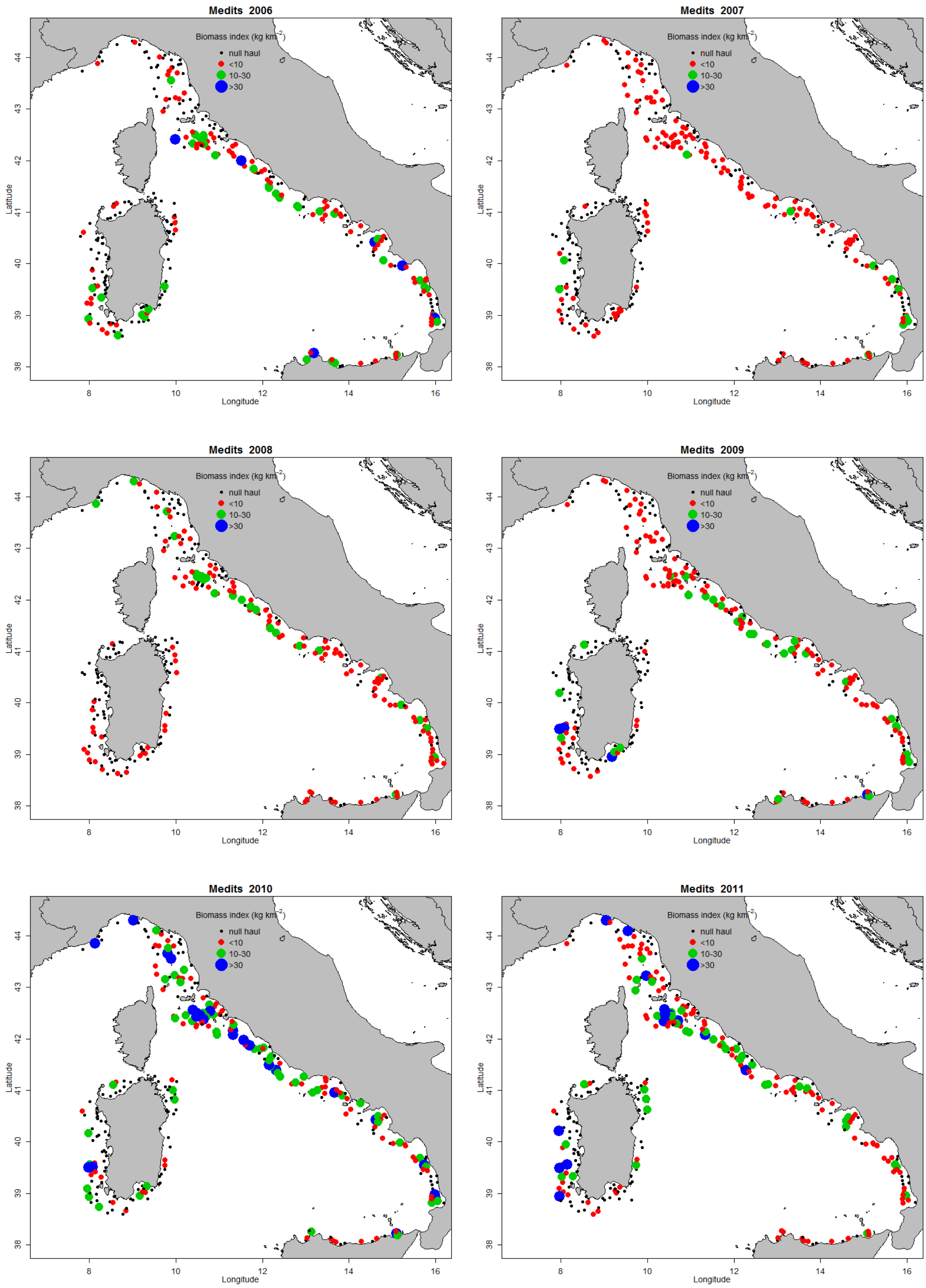


Figure 6.15.1.4.3 Deep-water rose shrimp in GSAs 9, 10 and 11. Distribution pattern in the period 2006-2011 (MEDITS survey).

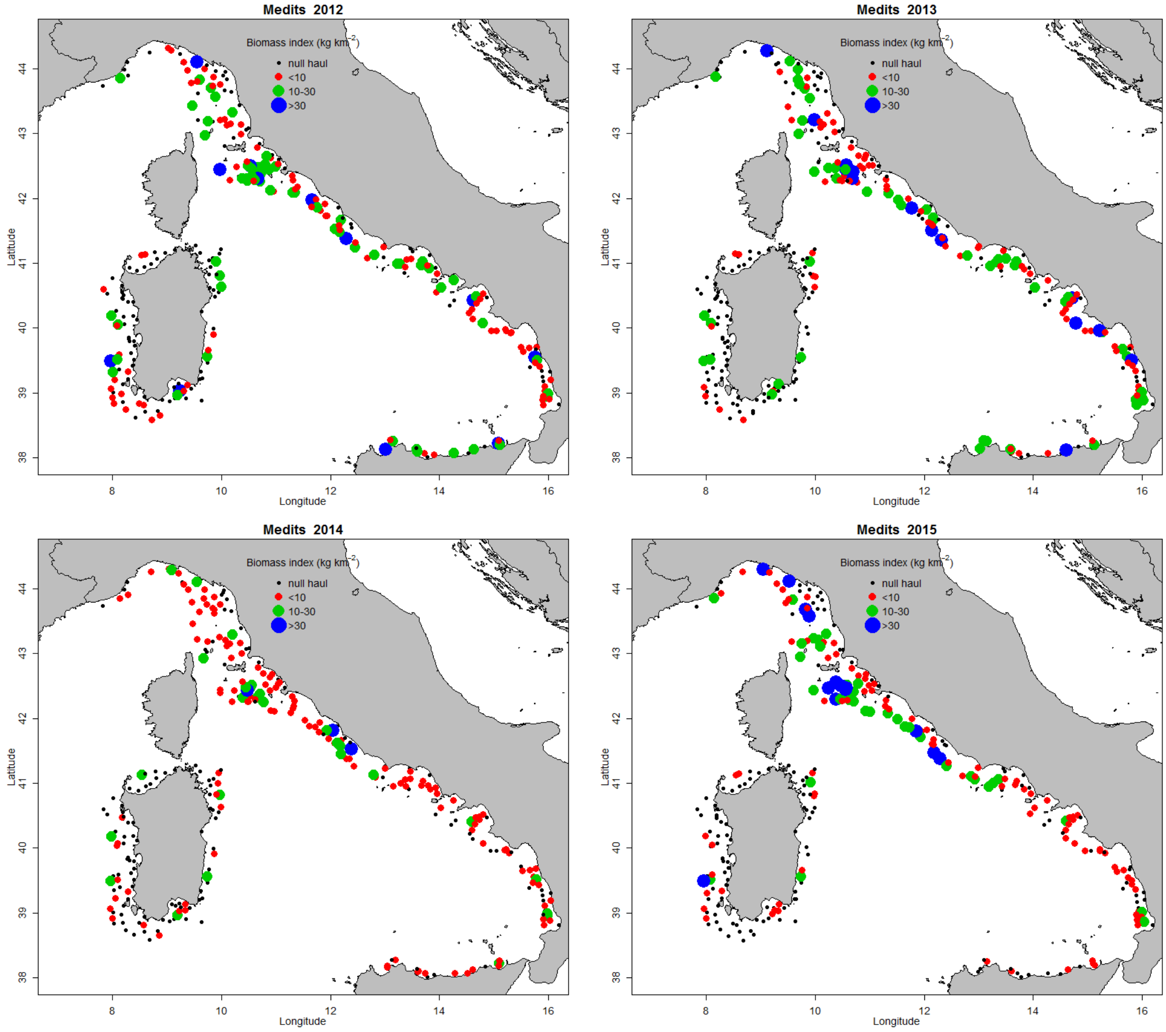


Figure 6.15.1.4.4 Deep-water rose shrimp in GSAs 9, 10 and 11. Distribution pattern in the period 2012-2015 (MEDITS survey).

Trends in abundance and biomass

The trends of the MEDITS indices (biomass and density) in the three GSAs are displayed in Figure 6.15.1.4.5.

The three data series are characterized by wide fluctuations. A first evident peak in all the GSAs is observed in 1999. Then, an increasing trend is detected in GSA 9 and 10, while in GSA 11 the values remained low in respect to the other two areas in particular in the last three years. In GSA 10, very high peaks, both in biomass and density, are observed in 2006, 2010 and 2012-2013. Then, the abundance dropped down in 2014 and 2015. A similar trend was observed in GSA 9, with the difference that in 2015 the highest value of the whole time series in the area is observed.

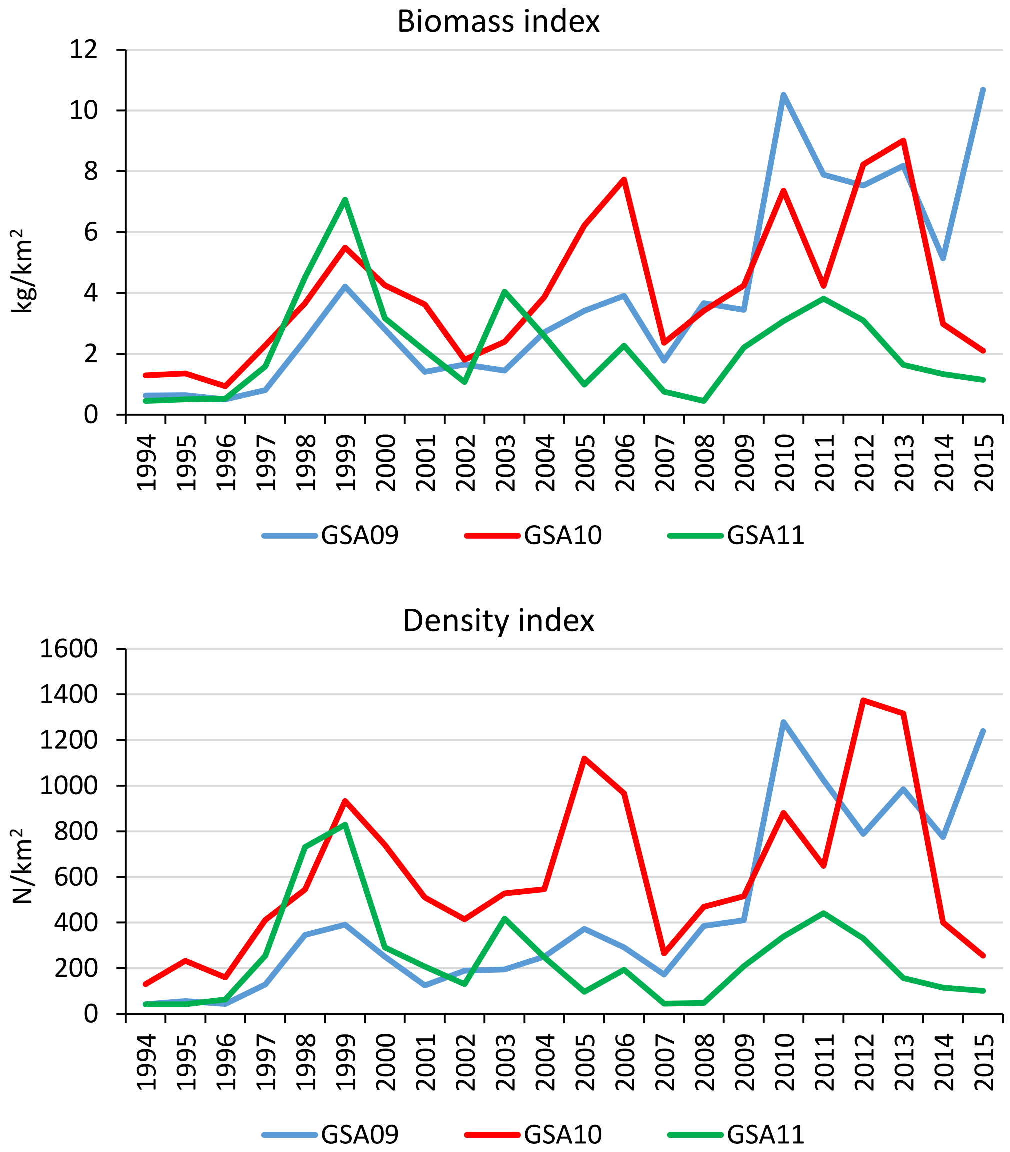


Figure 6.15.1.4.5 Deep-water rose shrimp in GSAs 9, 10 and 11. MEDITS standardized biomass and density indices (10-800 m).

Trends in abundance and biomass by length or age

Figs 6.15.1.4.6-8 displays the stratified abundance indices by length of the three GSAs during the MEDITS surveys from 1994 to 2015.

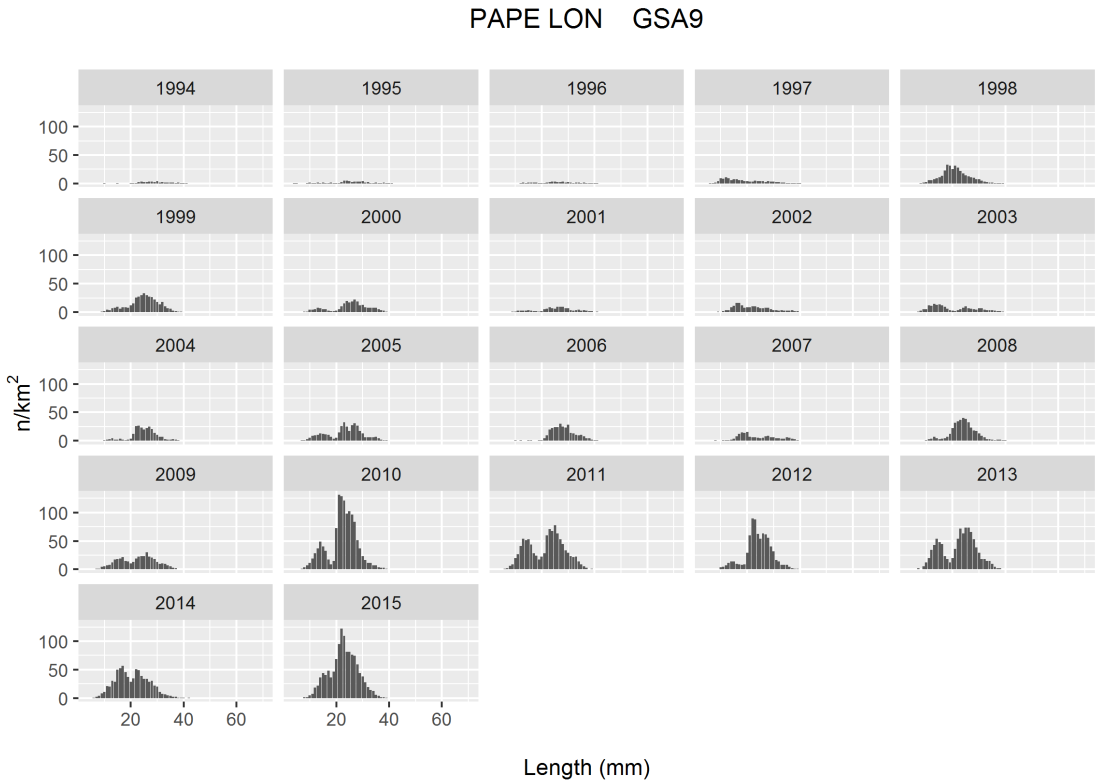


Figure 6.15.1.4.6 Deep-water rose shrimp in GSA 9. Stratified abundance indices by size for the total population, 1994-2015.

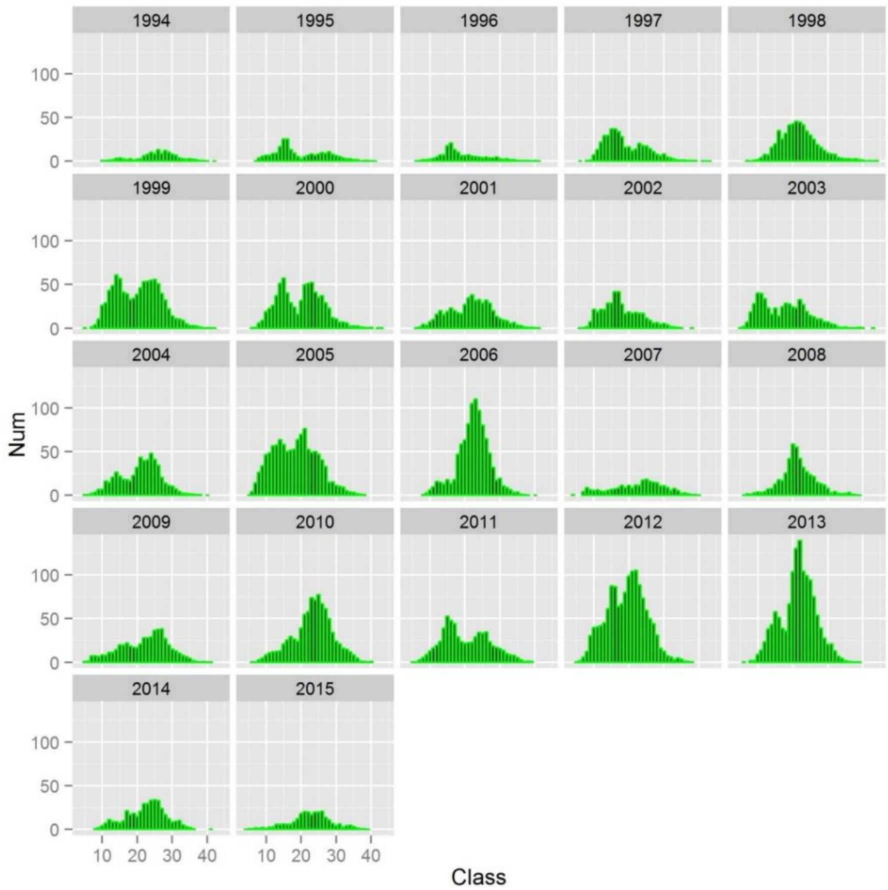


Figure 6.15.1.4.7 Deep-water rose shrimp in GSA 10. Stratified abundance indices by size for the total population, 1994-2015.

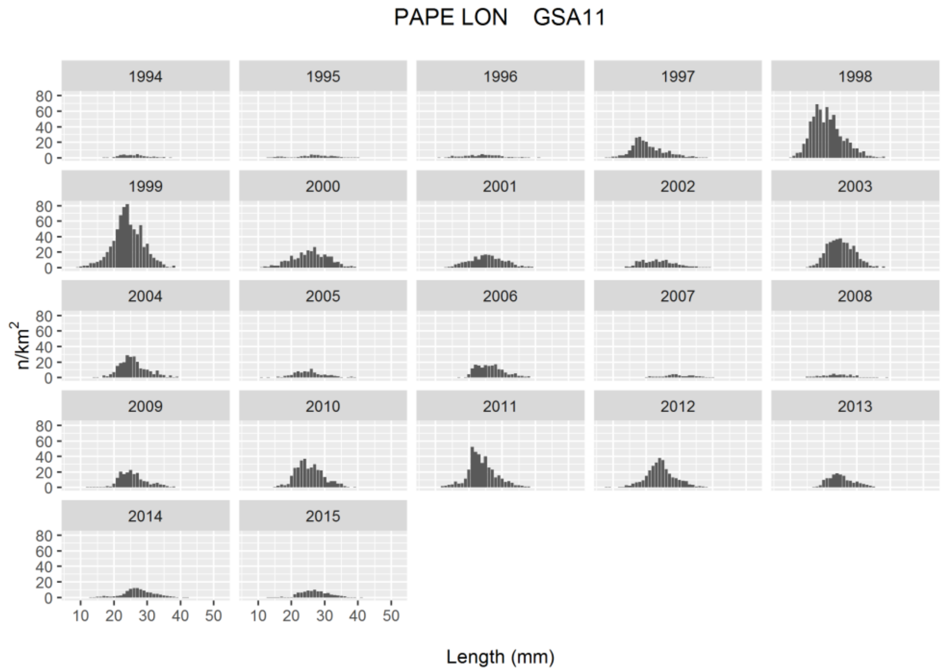


Figure 6.15.1.4.8 Deep-water rose shrimp in GSA 11. Stratified abundance indices by size for the total population, 1994-2015.

6.15.2 STOCK ASSESSMENT ON DEEP-WATER ROSE SHRIMP IN GSAs 9, 10 AND 11

Methods: XSA

An XSA assessment was carried out during EWG 16-17 using landing data collected under DCR-DCF from 2006 to 2015 and calibrated with survey data (MEDITS 2006-2015). FLR libraries were employed in order to perform the analyses. Discards were included in the analysis with the exception of GSA 11 for which data are not available. Since no discard data were available for 2007-2008 in GSAs 09 and 10, an estimate based on the average discard ratios and discard age structures of the available nearest years (2006, 2009-2011) has been calculated.

Input parameters

Data from DCF provided at EWG 16-17 for GSAs 09 and 10 contained information on deep-water rose shrimp catches and the respective age structure for 2006-2015. For GSA 11, catch data are available only for the period 2009-2015. For the years 2006-2008, the age structure was reconstructed using an average of the distributions available for the years 2009-2011. This has very little influence on the assessment as the catch on GSA 11 is a small proportion of the total. Plus group was set at age 3.
MEDITS data from the three GSAs for the period 2006-2015 were used for tuning.
Data used are reported in Table 6.15.2.2.1. A natural mortality vector computed using ProdBiom (Abella, 1997) was used. XSA analysis was performed by sex combined.
Given that the catches were composed mainly of individuals between 0 and 2 years, these ages were selected as the Fbar.

As in GSA 9 and 10 sum of products errors are small (typically less than 2%) and have been ignored.

Table 6.15.2.1 Deep-water rose shrimp in GSAs 9, 10 and 11. Input parameters for XSA.

Catch at age (thousands)	Age 0	Age 1	Age 2	Age 3+
2006	114495.9	85691.2	9263.8	1789.9
2007	102255.4	32567.3	4996.4	33.9
2008	55218.5	43193.0	2858.4	13.0
2009	50273.4	44554.6	4039.8	0.4
2010	45223.4	59624.8	4776.5	627.1
2011	86293.3	60002.2	3020.2	1413.0
2012	65615.1	67345.4	7099.4	771.0
2013	79661.7	73293.6	4022.1	1598.8
2014	82006.8	66354.0	5339.0	1522.2
2015	152400.5	74571.1	4671.6	951.8

Mean weight at age (Catches)	Age 0	Age 1	Age 2	Age 3+
2006	0.006	0.011	0.019	0.026
2007	0.004	0.012	0.019	0.026
2008	0.005	0.01	0.019	0.026
2009	0.004	0.011	0.018	0.026
2010	0.005	0.01	0.018	0.023
2011	0.004	0.011	0.019	0.025
2012	0.005	0.01	0.018	0.024
2013	0.005	0.011	0.018	0.023
2014	0.004	0.011	0.018	0.023
2015	0.004	0.011	0.018	0.024

Mean weight at age (Stock)	Age 0	Age 1	Age 2	Age 3+
2006	0.006	0.011	0.019	0.026
2007	0.004	0.012	0.019	0.026
2008	0.005	0.01	0.019	0.026
2009	0.004	0.011	0.018	0.026
2010	0.005	0.01	0.018	0.023
2011	0.004	0.011	0.019	0.025
2012	0.005	0.01	0.018	0.024
2013	0.005	0.011	0.018	0.023
2014	0.004	0.011	0.018	0.023
2015	0.004	0.011	0.018	0.024

Proportion of mature	Age 0	Age 1	Age 2	Age 3+

2006	0.03	0.93	1	1
2007	0.02	0.91	1	1
2008	0.02	0.90	1	1
2009	0.01	0.90	1	1
2010	0.02	0.86	1	1
2011	0.02	0.86	1	1
2012	0.02	0.86	1	1
2013	0.01	0.88	1	1
2014	0.01	0.88	1	1
2015	0.01	0.85	1	1

Natural mortality	Age 0	Age 1	Age 2	Age 3+
2006	1.45	0.87	0.75	0.7
2007	1.45	0.87	0.75	0.7
2008	1.45	0.87	0.75	0.7
2009	1.45	0.87	0.75	0.7
2010	1.45	0.87	0.75	0.7
2011	1.45	0.87	0.75	0.7
2012	1.45	0.87	0.75	0.7
2013	1.45	0.87	0.75	0.7
2014	1.45	0.87	0.75	0.7
2015	1.45	0.87	0.75	0.7

Tuning MEDITS data GSA09	Age 0	Age 1	Age 2	Age 3+
2006	15.0	198.8	54.7	10.3
2007	63.4	73.2	26.2	3.1
2008	80.3	250.8	26.0	5.1
2009	160.3	203.8	33.4	4.1
2010	345.5	541.6	56.1	5.8
2011	438.1	479.8	45.6	7.3
2012	160.4	547.3	70.6	9.0
2013	320.1	423.8	65.1	7.5
2014	399.1	323.9	36.9	5.7
2015	441.3	739.8	52.4	6.2

Tuning MEDITS data GSA10	Age 0	Age 1	Age 2	Age 3+
2006	305.4	233.1	7.8	0.3
2007	821.7	283.5	14.4	0.1
2008	458.2	494.5	14.0	0.2
2009	117.3	128.3	18.7	0.7
2010	297.5	160.1	10.7	0.6
2011	236.0	256.8	21.0	1.3
2012	338.3	499.9	42.1	1.2

2013	390.6	230.1	26.1	1.0
2014	964.2	395.9	13.1	0.1
2015	744.9	557.7	14.1	0.2

Tuning MEDITS data GSA11	Age 0	Age 1	Age 2	Age 3+
2006	83.3	86.9	5.2	0.2
2007	8.9	27.0	4.7	0.5
2008	28.2	15.5	1.9	0.1
2009	110.7	78.1	4.4	0.3
2010	184.9	138.3	3.2	0.0
2011	286.3	107.2	4.4	0.0
2012	214.2	93.5	4.1	0.0
2013	94.7	58.7	1.0	0.0
2014	39.3	66.0	3.7	0.2
2015	37.9	52.1	2.2	0.2

Results

XSA was run setting shrinkage at 0.5, 1.0, 1.5, 2.0, 2.5 and 3.0. As showed by Figure 6.15.21, the six different settings produced similar estimates of recruitment and SSB. Sh0.5 and Sh1.0 gave higher estimations of F.

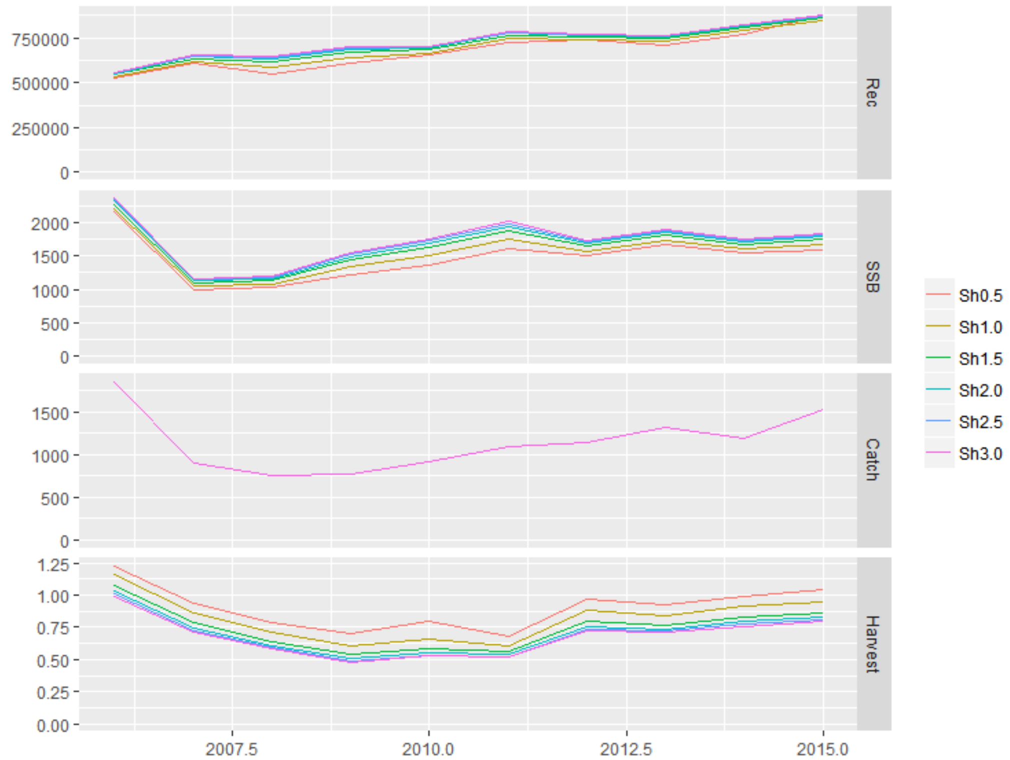


Figure 6.15.2.1. Deep-water rose shrimp in GSAs 9, 10 and 11. XSA outputs of different shrinkage scenarios.

Model with 1.5 shrinkage was adopted as final model based on the analysis of residual distributions (Figure 6.15.2.3.2). Residuals from tuning fleets (MEDITS) per age and year were relatively low, ranging from 2 to -2, and did not show any trend with time.

Moreover, a retrospective analysis was conducted on recruitment, mean F and SSB (Figure 6.15.2.3.1.3) to ensure the robustness of the final estimates. The retrospective series indicate very good agreement between years in the assessment results, with no systematic bias.

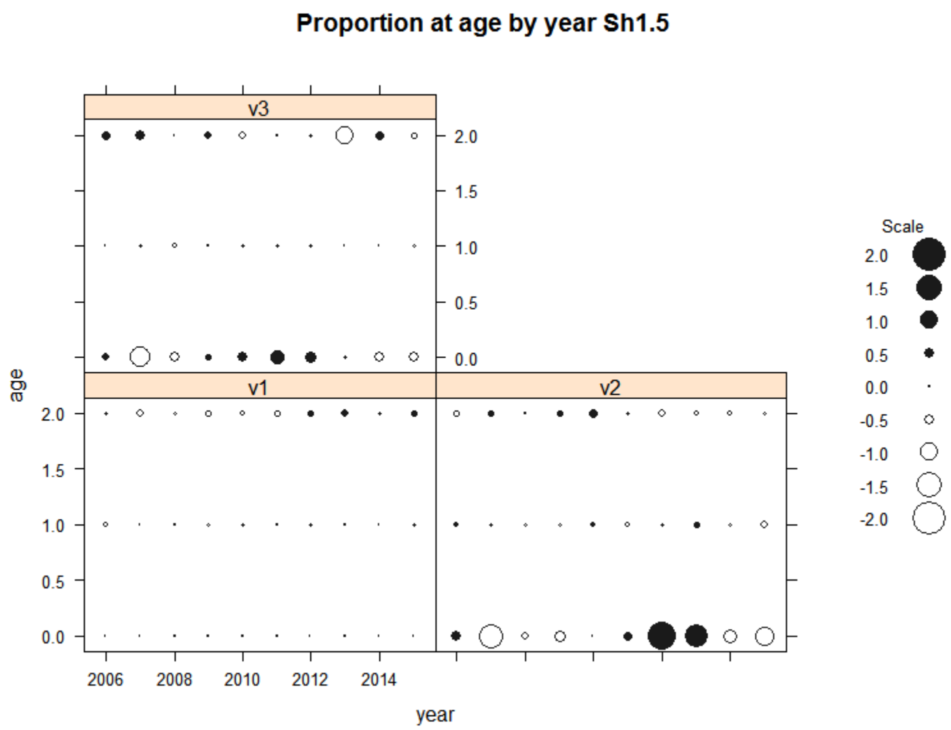


Figure 6.15.2.3.2 Deep-water rose shrimp in GSAs 9, 10 and 11. Residuals at age obtained with shrinkage set at 1.5. v1=GSA09, v2=GSA10, v3=GSA11.

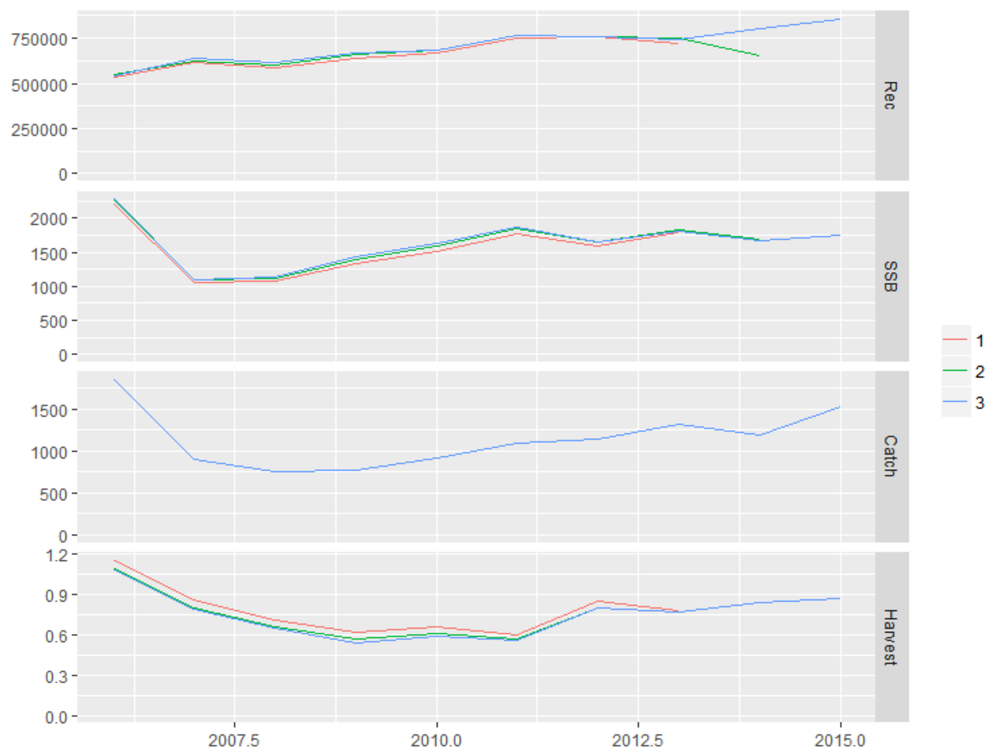


Figure 6.15.2..3 Deep-water rose shrimp in GSAs 9, 10 and 11. Retrospective analysis with shrinkage set at 1.5.

Based on these sensitivity analyses, the inputs reported in Table 6.15.2.3.1.1 were selected to run the final XSA.

Table 6.15.2.1 Deep-water rose shrimp in GSAs 09, 10 and 11. Inputs selected to run the final XSA.

fse	rage	qage	shk.n	shk.f	shk.yrs	shk.ages
1.5	1.0	2.0	TRUE	TRUE	3.0	3.0

XSA main outputs (Figure 6.15.2.3.1.3) showed an increasing trend in the catches and recruitment. Recruitment varied from a minimum of 543 million in 2006 to 858 million in 2015. SSB shows an increasing trend in the period 2007-2011; then, the value remained quite stable fluctuating around 1700 tons. In 2015 SSB was 1746.5 tons. Fishing mortality is characterized by a decreasing trend in the first part of the time series (2006-2009) and then the values remained stable until 2011. Since 2012 an increase of F is detected reaching the value of 0.87 (F_{curr}) in 2015. The total biomass of the stock dropped down at the beginning of the time series (5330 tons in 2006 to 3449 tons in 2007) and then a general increase was observed reaching a maximum in 2013. High values (above 5000 tons) have been estimated since 2010. XSA stock summary results are reported in the Tabs. 6.15.2.2-4.

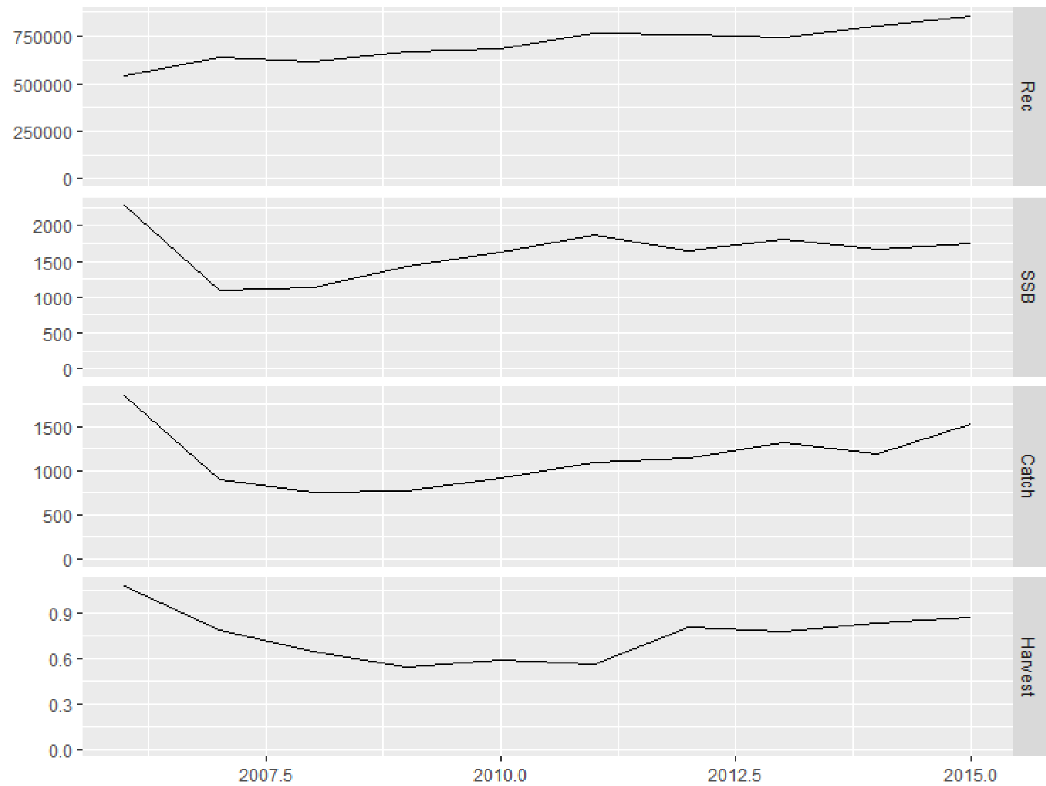


Figure 6.15.2.4 Deep-water rose shrimp in GSAs 9, 10 and 11. XSA summary results. SSB and catch are in tons, recruitment in thousands of individuals.

Table 6.15.2.2 Deep-water rose shrimp in GSAs 9, 10 and 11. Stock numbers-at-age (thousands) as estimated by XSA.

Age	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
0	543705	635035	615391	667611	682102	763013	754837	744492	805276	858333
1	165300	72084	99435	117610	132250	138100	137190	145280	136050	149180
2	20777	13788	9120	13701	20434	16815	19019	13884	13426	14051
3+	3684	87	39	1	2555	7544	1924	5215	3550	2687

Table 6.15.2.3 Deep-water rose shrimp in GSAs 9, 10 and 11. XSA summary results.

	F_{bar0-2}	Recruitment (thousands)	SSB (t)	TB (t)
2006	1.08	543705	2279.4	5330.6
2007	0.78	635035	1102.2	3449.5
2008	0.64	615391	1130.8	3797.0
2009	0.54	667611	1437.7	3732.0
2010	0.59	682102	1632.2	4716.4
2011	0.56	763013	1875.5	4653.7
2012	0.80	754837	1643.8	5286.3
2013	0.77	744492	1813.4	5366.4
2014	0.83	805276	1672.5	4772.5
2015	0.87	858333	1746.5	5315.8

Table 6.15.2.4 Deep-water rose shrimp in GSAs 9, 10 and 11. XSA summary results: F-at-age matrix.

	F-at-age			
	0	1	2	3+
2006	0.57	1.61	1.05	1.05
2007	0.40	1.20	0.75	0.75
2008	0.20	1.11	0.61	0.61
2009	0.17	0.88	0.56	0.56
2010	0.15	1.19	0.42	0.42
2011	0.27	1.11	0.30	0.30
2012	0.20	1.42	0.78	0.78
2013	0.25	1.51	0.55	0.55
2014	0.24	1.40	0.86	0.86
2015	0.46	1.48	0.66	0.66

Method 2. Length-based analysis

Length-based methods were used for deriving some indicators explored in WKLIFE IV. (ICES, 2015). They allow classifying the stocks according to conservation/sustainability, yield optimization and MSY considerations. Analysis required data on the stock catch/landings–length composition and life-history parameters as Linf.

The length-based indicators analysis was performed using the commercial landings in 2006 to 2015 (discards considered negligible) and the following life-history parameters: Linf=43.6 mm.

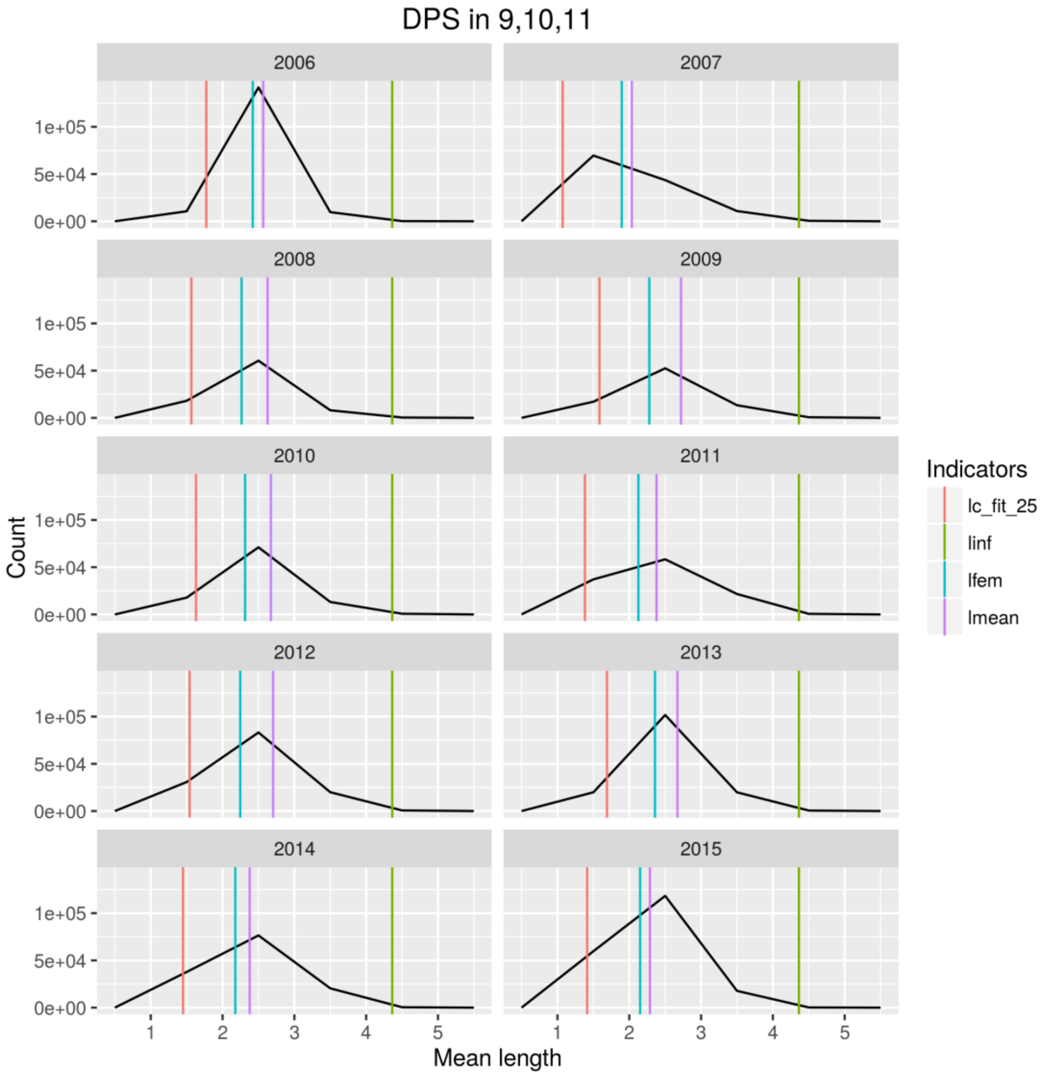


Figure 6.15.2.3.1.4. Deep-water rose shrimp in GSA 9,10 and 11. Length-based indicators and reference points for rose shrimp using the catch length composition for 2006, to 2015

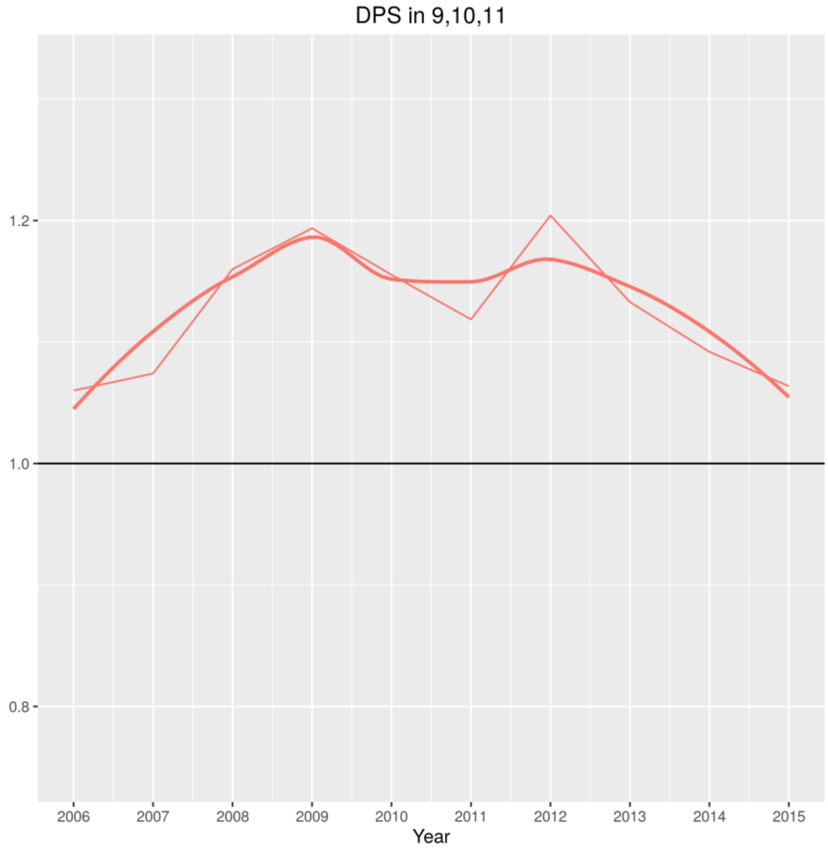


Figure 6.15.2.3.1.5. Deep-water rose shrimp in GSA 9,10 and 11. Length-based indicator for rose shrimp using the catch length composition for 2006 to 2015

The overall perception from length-based indicators is that the stock is being fished below MSY level. This supports the view of the XSA assessment. The indicator also supports the view of decreasing F in the first half of the period and a rising F in the later years.

6.15.3 REFERENCE POINT

The time series of SSB and R values is not sufficient to allow evaluation of S-R elements of MSY, so the WG has applied the STECF recommended method of F0.1. The yield per recruit (YpR) analysis was run using R routine (FLRBRP). The analysis was performed to estimate $F_{0.1}$ as target equilibrium YPR reference point for the stock. YpR output curve is illustrated in the Figure 6.15.3.1, while in Figure 6.15.3.2 $F_{0.1}$ and F_{bar} are compared. $F_{0.1}$ estimated by the model was 0.91.

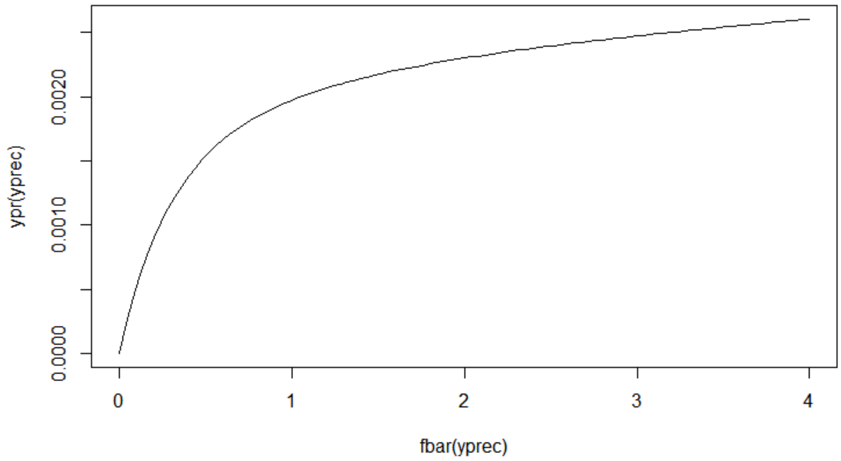


Figure 6.15.3.1 Deep-water rose shrimp in GSAs 9, 10, 11. Yield per Recruit curve.

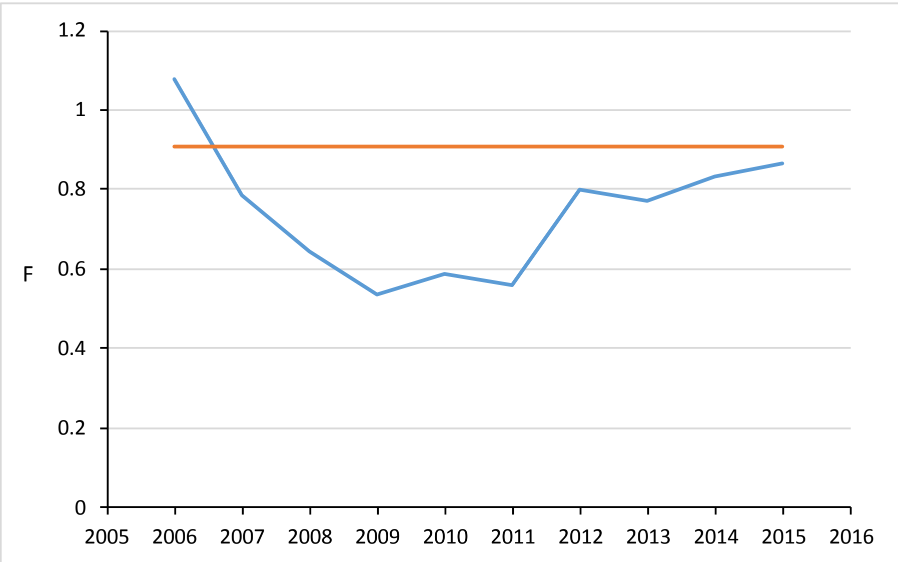


Figure 6.15.3.2 Deep-water rose shrimp in GSAs 9, 10 and 11. Trend of F_{bar} obtained by means of XSA and comparison with $F_{0.1}$.

According to the F estimates obtained using landing and discard data with XSA, F_{curr} was below the estimated reference value of $F_{0.1}$=0.91 with the only exception of 2006. STECF-EWG 16-17 considers the stock has been harvested sustainably (fully exploited) consistent with high long-term yield and lower risk of stock collapse. It is important to take into account that this stock is strongly affected by environmental and ecological factors (e.g. water temperature, predatory release effect) that can make difficult to evaluate the effect of fishing on the stock. EWG 16-17 advises to not increase the current level of effort of the relevant fleets, in order to avoid future loss in stock productivity.

In case management measures are put in place, it is important to take into account the different fishing patterns observed by comparing the three GSAs (9, 10 and 11). The estimation of the fishing mortality by fleet is obtained splitting the overall fishing mortality from XSA using proportions of catch in number by age and fleet by means of FLR script provided by JRC Figure 6.15.3.3), this shows the trends of fishing pattern in the three areas.

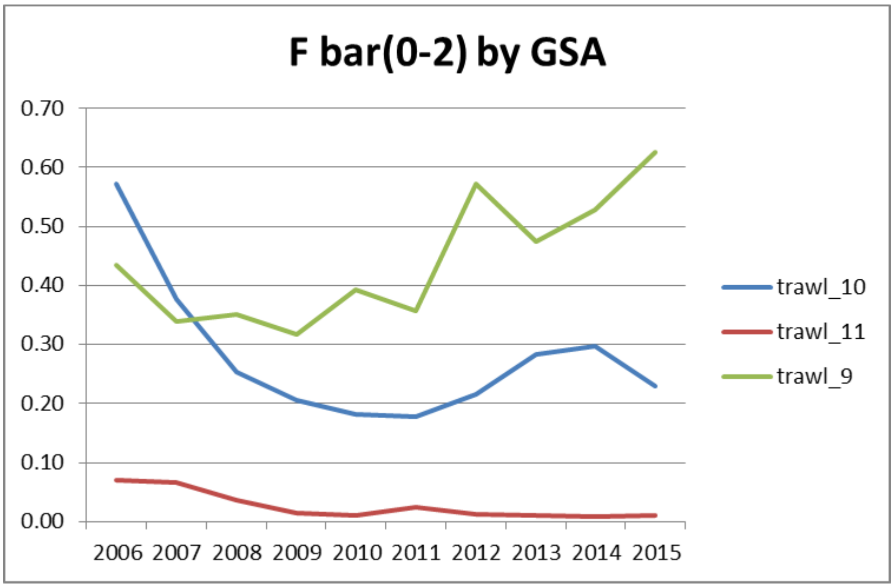


Figure 6.15.3.3 Deep-water rose shrimp in GSAs 9, 10 and 11. Trend of F_{bar} by fleet obtained splitting F estimates from XSA using proportion of catch in number by age and fleet with FLR script provided by JRC.

Also the fishing mortality exerted on the age groups (Figure 6.15.3.4) is quite different by area: in GSA 10 is notably higher on 0 and 1 age groups, while in GSA 9 on 1, 2 and 3+ groups. This is one of the main reasons explaining the results observed in the assessments conducted singularly on each GSA, where the species resulted overexploited in GSA 10 and fully exploited in GSA 9.

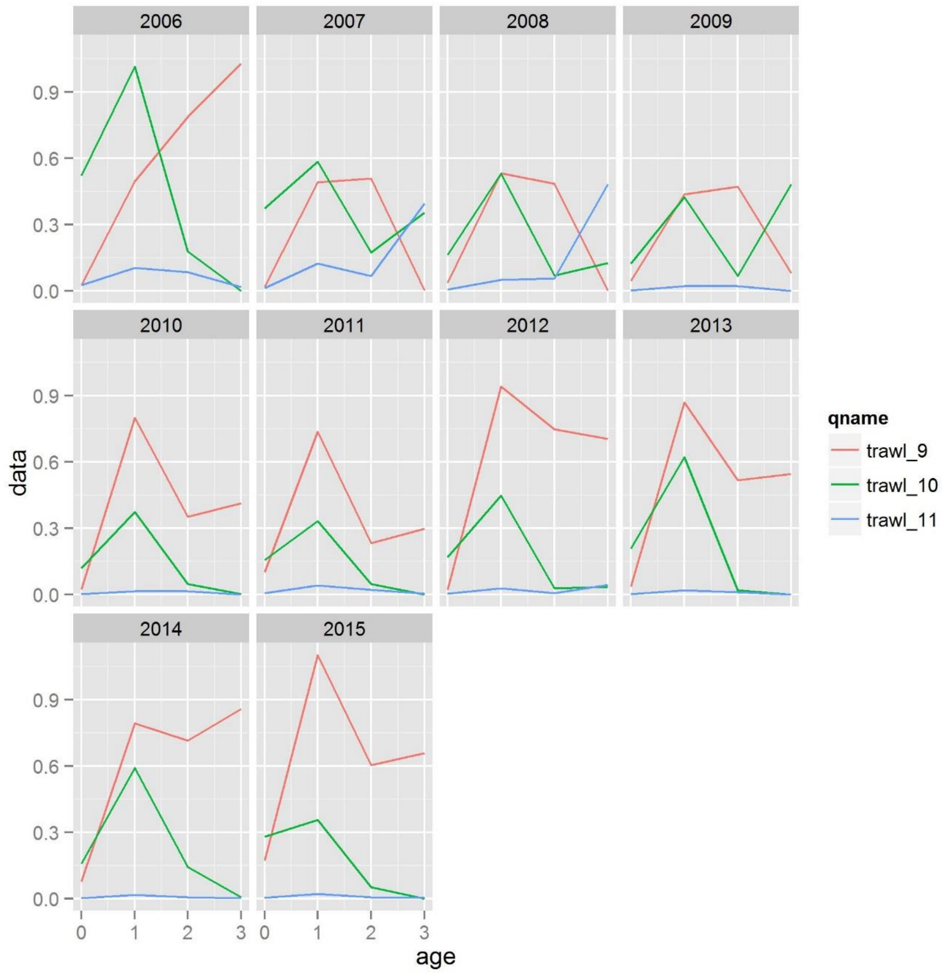


Figure 6.15.3.4 Deep-water rose shrimp in GSAs 9, 10 and 11. Trend of F_{bar} by age observed in each GSA along the time series.

6.15.4 SHORT TERM FORECAST

A deterministic short-term prediction for the period 2016 to 2018 was performed using the FLR routines and based on the results of the XSA stock assessment.

The input parameters for the deterministic short-term predictions for the period 2016 to 2018 were the same used for the XSA stock assessment and its results. An average of the last three years has been used for weight at age, maturity at age and F at age.

Recruitment (age 0) has been estimated from the population results as the geometric mean of the last 3 years (801346 thousand individuals).

A short-term projection of the trawlers fleet (Table 6.15.4.1) fishing at the status quo (F=0.82) generates a decrease of the catch of 3.25% from 2015 to 2017 along with an approximately stable spawning stock biomass (change 0.51%) from 2017 to 2018. Fishing at $F_{0.1}$ (0.91) generates an increase of the catch of 3.16% from 2015 to 2017 and a decrease of the spawning stock biomass of 4.34% from 2017 to 2018.

Table 6.15.4.1 Deep-water rose shrimp in GSAs 9, 10 and 11. Short term forecast in different F scenarios. The input parameters from XSA stock assessment weight at age, maturity at age and F at age, averages 2013-15. Recruitment (age 0) geomean 2013-15 (801346 thousand individuals).

F2016 status quo (F=0.82) gives catch 1435.38,

Rationale	Ffactor	Fbar	Catch 2017	Catch 2018	SSB 2017	SSB 2018	Change SSB 2017-2018(%)	Change Catch 2015-2017(%)
Zero catch	0	0	0	0	1674.64	3056.82	82.54	-100
High long term yield (F0.1)	1.102	0.91	1585.32	1544.60	1674.64	1601.99	-4.34	3.16
Status quo	1	0.82	1486.83	1489.91	1674.64	1683.23	0.51	-3.25
Different Scenarios	0.2	0.16	403.49	534.02	1674.64	2660.63	58.88	-73.74
	0.3	0.25	579.72	736.58	1674.64	2492.39	48.83	-62.28
	0.4	0.33	741.50	906.07	1674.64	2340.80	39.78	-51.75
	0.5	0.41	890.46	1048.27	1674.64	2203.80	31.60	-42.06
	0.6	0.49	1028.00	1167.94	1674.64	2079.63	24.18	-33.11
	0.7	0.58	1155.39	1269.00	1674.64	1966.74	17.44	-24.82
	0.8	0.66	1273.70	1354.66	1674.64	1863.80	11.30	-17.12
	0.9	0.74	1383.91	1427.57	1674.64	1769.63	5.67	-9.95
	1.1	0.90	1583.23	1543.48	1674.64	1603.71	-4.24	3.02
	1.2	0.99	1673.73	1589.78	1674.64	1530.30	-8.62	8.91
	1.3	1.07	1758.93	1630.01	1674.64	1462.34	-12.68	14.45
	1.4	1.15	1839.32	1665.19	1674.64	1399.23	-16.45	19.68
	1.5	1.23	1915.36	1696.16	1674.64	1340.47	-19.95	24.63
	1.6	1.32	1987.43	1723.61	1674.64	1285.61	-23.23	29.32
	1.7	1.40	2055.88	1748.12	1674.64	1234.25	-26.30	33.78
	1.8	1.48	2121.04	1770.15	1674.64	1186.06	-29.18	38.02
	1.9	1.56	2183.17	1790.11	1674.64	1140.72	-31.88	42.06
	2	1.64	2242.51	1808.33	1674.64	1097.98	-34.43	45.92

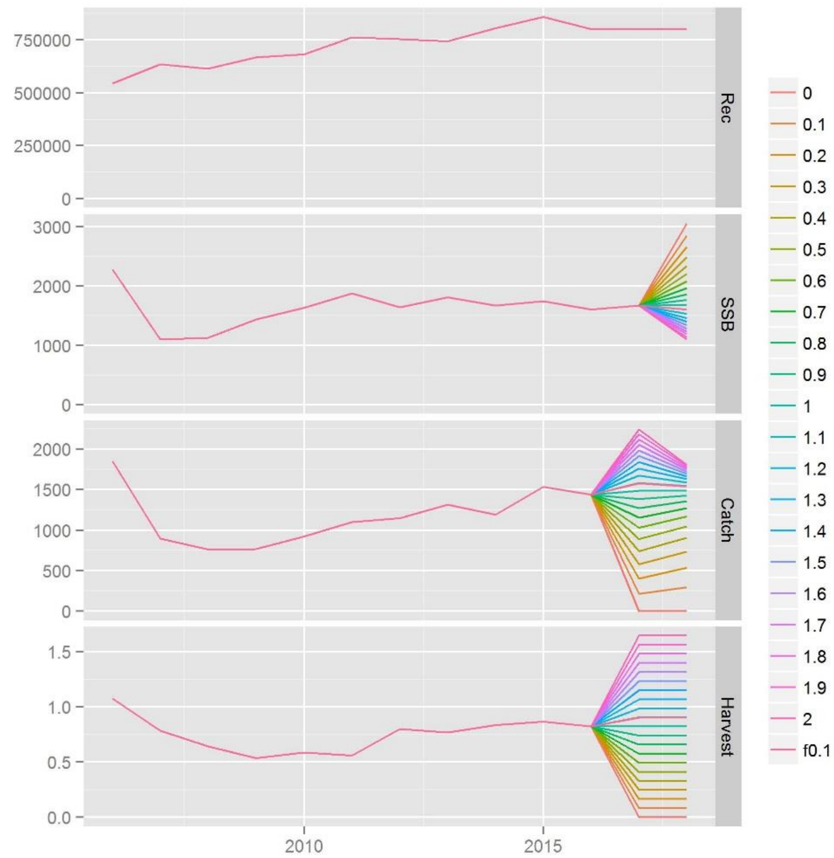


Figure 6.15.4.1 Deep-water rose shrimp in GSAs 9, 10 and 11. Short-term forecast in different F scenarios.

6.15.5 QUALITY AND PROPOSALS FOR FUTURE ASSESSMENTS

Data from EU DCF as submitted through the Official data call in 2016 were used. The time series of the demographic structures of landing were different according to the three GSAs: 2003-2015 for GSA 11, 2006-2015 for GSA 09 and 2009-2015 for GSA 11. Due to those differences, the analyses were carried out on the period 2006-2015. An extrapolation of the data for the years 2006-2008 has been made for GSA 11, taking into account that the landing of deep-water rose shrimp in this area has a low weight in comparison to the other two GSAs.

Discards data in GSAs 09 and 10 were missing for 2007 and 2008 as their collection was not compulsory. Data available in the other years were used to raise the lacking ones (see methodology in the single assessments of the two GSAs). Discard was not available for GSA 11; however, this fraction was considered negligible.

One combined set of growth parameters has been furnished for GSA 11. This could affect the slicing of the length frequency distributions of the catches and MEDITS data as the species is characterised by significant differences in the growth rates between the two sexes.

6.16 COMMON SOLE IN GSA 7

6.16.1 DATA GATHERING OF COMMON SOLE IN GSA 7

6.16.1.1 Stock Identity and Biology

Common sole is distributed from Eastern Atlantic (southward from Trondheim Fjord, also North Sea and western Baltic) and Mediterranean (also Sea of Marmara, Bosphorus and south-western Black Sea). Is a benthic species that inhabits on sandy and muddy bottoms, from the shore down to 300 m. (FAO sheet, http://www.fao.org/fishery/species/3367/en)

Stock identification was evaluated by STOCKMED (Fiorentino et al, 2014) and they are concluded that there is no enough information to define the number of stocks present in the Mediterranean. STOCKMED suggest a configuration of 5 stock units, but it is considered uncertain.

The present assessment covers the entire GSA 7 area corresponding to the Gulf of Lions. Due to the lack of conclusive information about the stock structure of the common sole population in the western Mediterranean, this stock was assumed to be confined within the GSA 7 boundaries in this assessment.

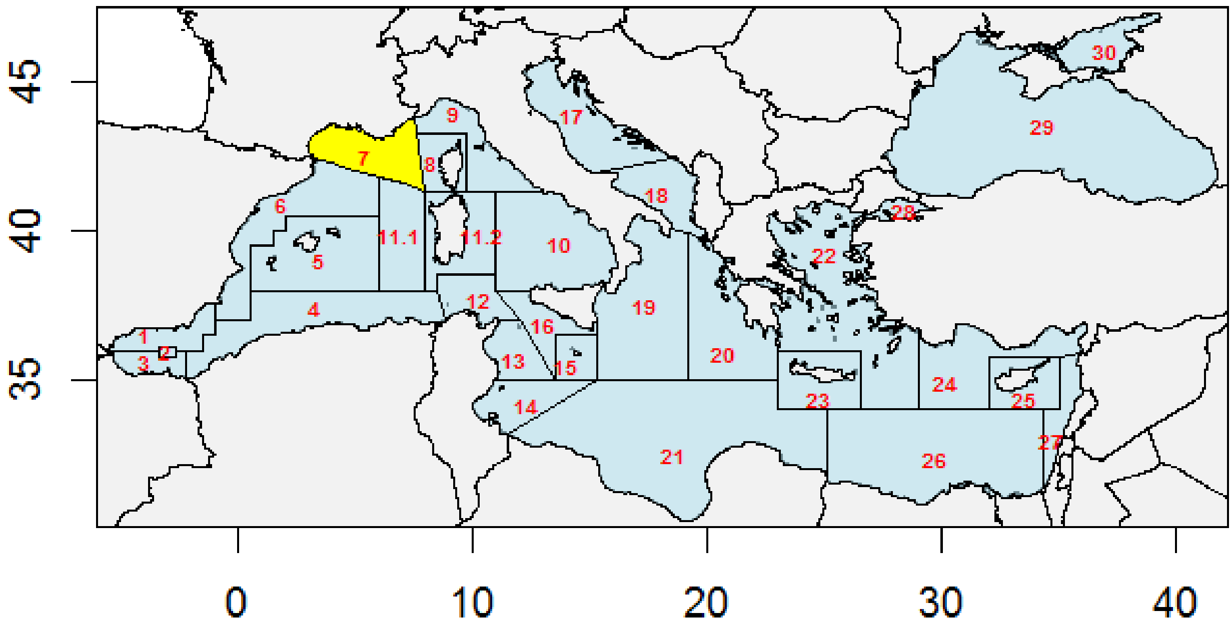


Figure 6.16.1.1.1. Geographical location of GSA 7.

Growth

The species can reach the size of 70 cm TL, common 15-45 cm (FAO sheet, http://www.fao.org/fishery/species/3367/en).

There are not defined growth parameters for Common sole (SOL) in the GSA7 on the DCF. There are VBGP in other GSA's that are shown in the following table:

	Linf	k	t_0	Sex

GSA9	37	0.65	-0.5	Combined (2002)
GSA10	39.6	0.4	-0.46	Combined (2005,2006, 2013, 2014, 2015)
GSA11	40	0.679	0	Combined (2012)
GSA17	33.7	0.604	-0.92	Combined (2011)
GSA17	38.3	0.412	-1.34	Combined (2012)
GSA17	32	0.785	-0.71	Combined (2013)
GSA17	34.6	0.576	-0.96	Females (2011)
GSA17	37.1	0.479	-1.21	Females (2012)
GSA17	32.4	0.84	-0.65	Females (2013)
GSA17	29.7	0.867	-0.7	Males (2011)
GSA17	31.9	0.613	-1.08	Males (2012)
GSA17	30.1	0.808	-0.77	Males (2013)

All of them have a Linf value very low compared with the Lmax observed in catches (53 cm). Wider exploration of growth parameters established that in FISHBASE a set of growth parameters sex combined for the Gulf of Lions (GSA7), these appear to more adequately represent the observed catches and have been used in the present assessment:

	Linf	k	t_0	Sex
GSA7	48.8	0.24	-0.77	Combined (FISHBASE)

On the case of length-weight relationship, there are no compiled parameters “a” and “b” of the SOL for GSA 7. Again we have used a set of parameters compiled in FISHBASE that corresponds to the Gulf of Lions (GSA 7) and sex combined: a=0.00622, b=3.04

Maturity

The species spawn from January to April, with a peak in February in the Mediterranean (FAO sheet, http://www.fao.org/fishery/species/3367/en).

There are no data on age maturity for Common sole in the GSA 7. Maturity vector has been constructed from length at maturity data for the GSA 9, and it is the following:

	0	1	2	3	4	5+
Maturity (age)	0.047	0.36	0.95	1	1	1

Natural Mortality

Natural mortality vector has been estimated with PRODBIOM spreadsheet from the growth parameters used and it is the following:

	0	1	2	3	4	5+
M (Prodbiom)	0.46	0.19	0.14	0.12	0.1	0.1

6.16.1.2 Catch data

Data on Common sole landings in GSA 7 are reported for the period 2002-2015 in the DCF. French data that represent the 99% of the landings are available for the period 2009-2015. Total landings by country are shown in the following Table and figure:

Table 6.16.1.2.1. Common sole GSA 7. Total landings by country and year.

Common sole, Total landings (tons)/year				
year	ESP	FRA	Total (ESP+FRA)	%FRA
2002	1.3		1.3	
2003	1.0		1.0	
2004	1.0		1.0	
2005	1.5		1.5	
2006	1.5		1.5	
2007	1.5		1.5	
2008	1.2		1.2	
2009	0.7	96.8	97.5	99.3
2010	0.5	104.2	104.7	99.5
2011	0.5	176.4	176.9	99.7
2012	0.3	168.1	168.4	99.8
2013	0.4	248.6	249.0	99.9
2014	0.3	210.7	211.1	99.8
2015	0.4	184.1	184.4	99.8

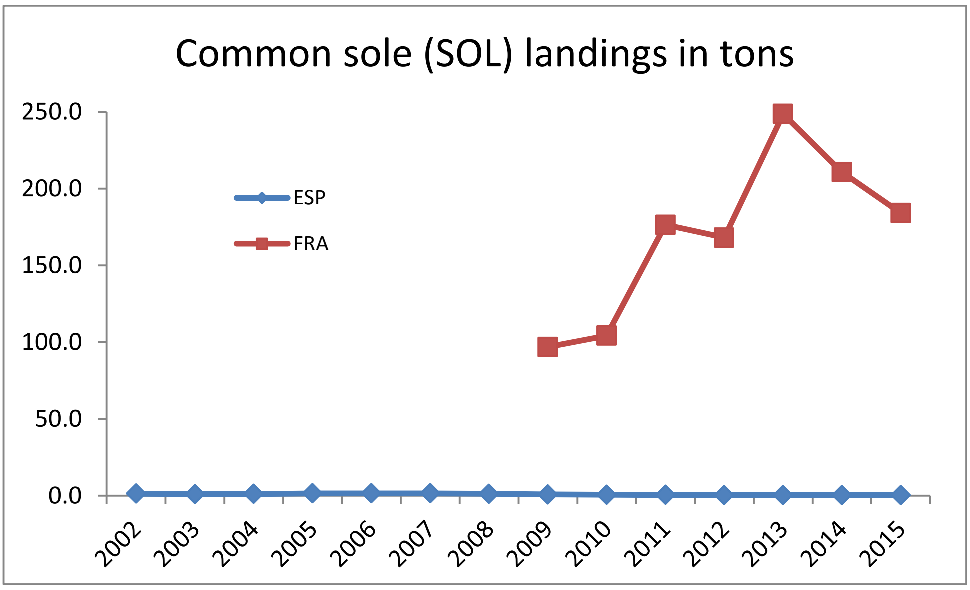


Figure 6.16.1.2.1. Common sole GSA 7. Total landings by country and year.

French landings on Common sole in GSA 7 have an increasing trend during the period 2009 to 2015.
Landings data by fishing gear any year are presented by country (data are in tons)

Spanish landings are shown in the following Table and correspond mainly to OTB fleet:

Table 6.16.1.2.2. Common sole GSA 7. Spanish (ESP) landings by gear: OTB (Bottom Otter Trawl), GNS (Gillnet), GTR (Trammel net). Data are in tons.

ESP SOL landings (tons)/fishing gear/year						
year	GNS	GTR	LLS	OTB	Total ESP	%OTB
2002	0.04	0.03	0	1.25	1.32	94.7
2003	0.04	0.01	0	0.9	0.95	94.7
2004		0		1.03	1.03	100
2005		0.05	0	1.44	1.49	96.6
2006				1.48	1.48	100
2007		0.05		1.47	1.52	96.7
2008			0	1.16	1.16	100
2009		0.13	0.02	0.57	0.72	79.2
2010	0	0.13	0	0.38	0.51	74.5
2011		0.09	0	0.36	0.45	80.0
2012		0.05	0	0.28	0.33	84.8
2013		0.04	0.03	0.29	0.36	80.6
2014		0.04	0.01	0.28	0.33	84.8
2015		0.07		0.28	0.35	80.0

French landings for SOL in GSA7 are distributed in 14 different gears, and are available for the period 2009 to 2015. However, considering OTB+GNS+GTR, it is often more than 90% of the catch (see Table and Figure). OTB series has landings data for 2009 to 2015, while landings data on artisanal gears are from 2011 to 2015 (except GTR in 2012). The complete series of landings by gear (OTB, GNS, GTR) covers only 4 years (2011, 2013, 2014 and 2015). OTB represents around 29% of landings, GNS 8% and GTR is the main gear that catches Common sole (55% of landings).

Table 6.16.1.2.3. Common sole GSA 7. French (FRA) landings by gear. Data are in tons.

FRA SOL landings (tons)/fishing gear/year															
year	-1	DRB	FPO	FYK	**GNS**	**GTR**	LHP	LLD	LLS	**OTB**	OTM	OTT	PS	SB	Total FRA
2009										**96.8**					96.8
2010										**104.2**					104.2
2011		4.0			**7.2**	**104.7**				**60.6**					176.4
2012					**102.6**					**65.4**					168.1
2013		9.7	6.1		**36.8**	**128.7**				**67.2**					248.6
2014	4.7	5.4	0.01	3.5	**5.6**	**134.7**				**53.3**	0.2	3.2			210.7
2015	5.8	3.3	2.1	0.6	**16.5**	**98.2**	0.7	0.2	0.01	**51.4**	1.1	2.5	1.2	0.3	184.1

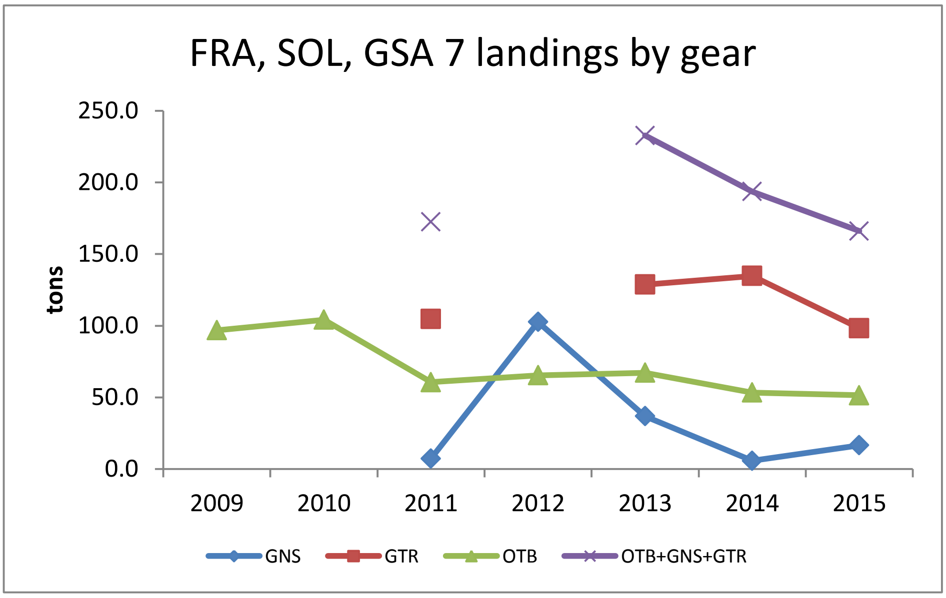


Figure 6.16.1.2.2. Common sole GSA 7. French landings by gear: OTB, GNS, GTR. Data are in tons

Length frequency data is only available for Spanish fishery OTB landings in the 2009 and 2010 years and the sampling is poor. There are no length frequencies for the rest of the series. Data range is 33-48 cm. Length frequency data is shown in the following table:

Table 6.16.1.2.4. Common sole GSA 7. ESP OTB length frequencies. Data are in thousands.

Length (cm)	OTB-2009	OTB-2010
33	0.27	0
34	0.61	0.06
35	0.23	0.13
36	0.09	0
37	0.18	0.38
38	0.12	0.21
39	0	0.06
40	0	0
41	0.04	0
42	0.14	0
43	0	0
44	0	0
45	0	0
46	0	0
47	0	0
48	0.04	0

French length frequency distribution of SOL in GSA7 by fishing gear and year are available for OTB for the period 2009 to 2015, and for the period 2011 to 2015 in the case of the main artisanal gears (GNS, GTR). This information is shown in the following tables and figures:

Table 6.16.1.2.5. Common sole GSA 7. FRA OTB length frequencies. Data are in thousands.

Length	OTB-2009	OTB-2010	OTB-2011	OTB-2012	OTB-2013	OTB-2014	OTB-2015

(cm)							
12	0	0	0.4	0	0	0	0
13	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
15	2.0	0	0.4	0	0	0	0.3
16	4.5	0.3	0.4	0	0	0	0.4
17	3.2	0.7	1.1	365.9	0	0	0.8
18	12.0	0.9	1.2	110.6	0.1	0.02	1.5
19	14.8	1.3	2.6	626.2	0.2	0.4	2.4
20	16.3	1.7	2.4	3254.9	0.8	1.4	2.5
21	19.7	2.5	2.6	2794.4	1.5	1.4	2.9
22	13.4	4.9	1.5	4213.9	2.4	1.2	3.7
23	6.7	3.5	2.2	4380.9	2.4	1.5	4.9
24	11.3	4.3	3.5	4176.6	3.8	1.1	6.4
25	13.3	9.8	3.3	8098.0	6.6	1.4	7.2
26	16.1	15.9	4.2	9085.7	6.3	4.2	8.4
27	14.9	14.9	6.7	12587.5	7.8	5.9	10.4
28	30.1	16.5	9.0	15949.5	12.1	5.7	13.4
29	27.6	22.2	13.9	21764.0	15.3	11.3	13.7
30	20.2	25.2	16.5	23246.6	17.3	12.6	14.0
31	20.9	33.5	16.8	20254.7	14.9	13.5	12.5
32	17.5	27.2	12.3	17276.0	16.8	12.8	11.5
33	16.8	22.5	13.9	15836.8	12.3	9.9	11.4
34	13.2	20.7	11.3	14384.3	14.0	12.5	11.5
35	14.3	23.0	12.0	12960.2	14.7	10.5	10.9
36	17.9	16.2	11.5	11660.9	13.0	10.7	11.6
37	12.4	13.8	10.7	7398.2	11.2	10.3	7.1
38	8.3	12.1	6.6	5978.1	10.4	9.0	7.9
39	10.9	8.4	5.8	5474.9	7.0	6.3	5.2
40	12.5	8.2	5.2	3998.0	5.8	5.8	3.6
41	2.4	3.0	3.2	1318.1	4.1	3.1	1.2
42	2.6	2.4	1.5	2327.9	2.7	2.3	1.2
43	1.0	2.9	0.7	1150.0	1.7	1.0	0.6
44	0.2	0.9	1.0	443.9	0.5	0.5	0.2
45	0.2	1.1	0.2	175.3	0.7	0.6	0.2
46	0	0.0	0.2	241.2	0.0	0.1	0.3
47	0	0.0	0	0	0.1	0.6	0
48	0	0.5	0	92.4	0	0	0
49	0	0	0	0	0	0	0
50	0	0	0	0	0.1	0	0

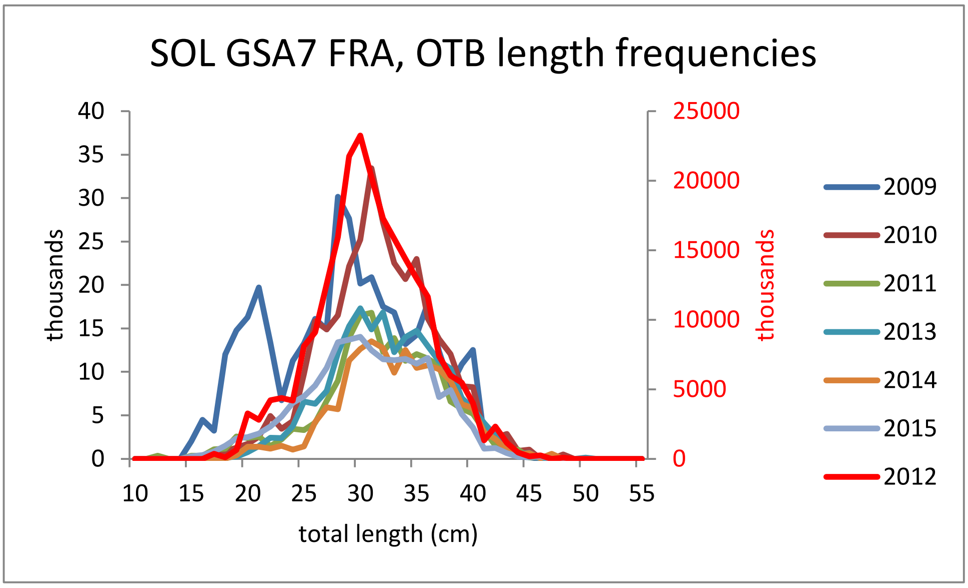


Figure 6.16.1.2.3. Common sole GSA 7. FRA OTB length frequencies. Data are in thousands. 2012 length frequency is represented in the right axis.

Table 6.16.1.2.6. Common sole GSA 7. FRA GNS length frequencies. Data are in thousands.

Length (cm)	GNS-2011	GNS-2012	GNS-2013	GNS-2014	GNS-2015
10	0	0.8	0	0	0
11	0	0	0	0	0
12	0	2.0	0	0	0
13	0	0	0	0	0
14	0	2.5	0	0	0
15	0	0.8	0	0	0
16	0	0.6	0	0	0
17	0	0	0.3	0	0
18	0	0	0.3	0	0
19	0	0	1.2	0	0
20	0.1	0.9	0.9	0	0
21	0.3	2.1	3.0	0	0
22	0.7	1.4	5.6	0	0
23	0.7	7.5	5.6	0.01	0
24	1.4	5.5	7.4	0.1	0.1
25	2.1	15.6	7.4	0.1	0.1
26	3.1	13.4	11.3	0.1	0.4
27	3.6	19.1	10.4	0.1	0.3
28	3.3	26.9	8.6	0.1	0.6
29	2.6	34.2	15.4	0.05	0.8
30	2.9	39.7	12.5	0.05	1.1
31	1.8	43.8	10.1	0.05	1.1
32	1.8	30.1	8.9	0.1	0.6
33	1.1	23.1	9.2	0.04	0.6

34	1.2	20.5	5.9	0.04	0.5
35	0.6	18.6	6.5	0.03	0.4
36	0.4	11.7	5.6	0.04	0.3
37	0.4	9.0	3.3	0.04	0.3
38	0.4	7.3	1.5	0.02	0.4
39	0.1	4.8	1.8	0.01	0.1
40	0.05	3.7	0.6	0	0.04
41	0.05	0.6	0	0	0.1
42	0.05	0.9	0	0	0
43	0	0	0	0	0
44	0	0	0	0	0
45	0	0.3	0	0	0
46	0	0	0	0.01	0

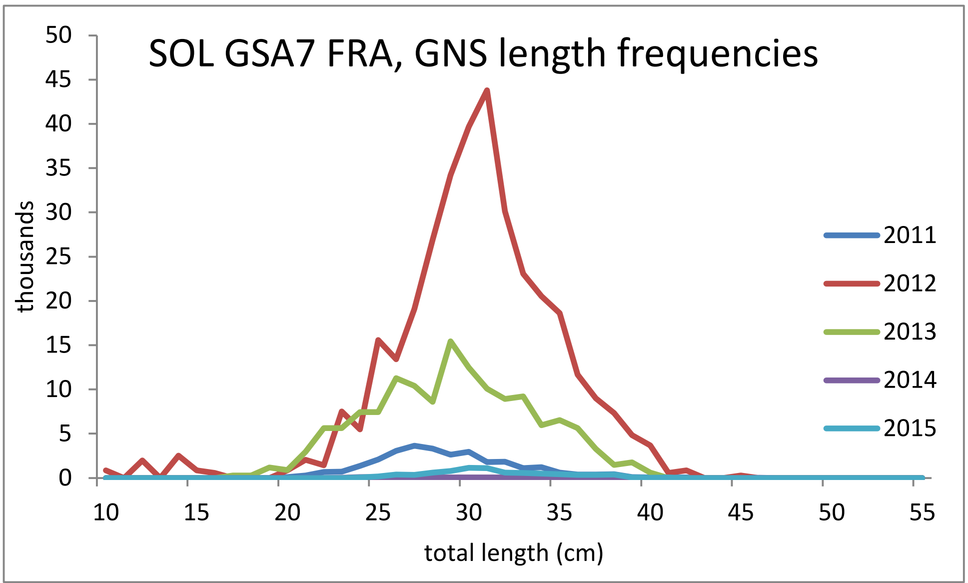


Figure 6.16.1.2.4. Common sole GSA 7. FRA GNS length frequencies. Data are in thousands.

Table 6.16.1.2.7. Common sole GSA 7. FRA GTR length frequencies. Data are in thousands.

Length (cm)	GTR-2011	GTR-2012	GTR-2013	GTR-2014	GTR-2015
17	1.0		0.01	0	0
18	1.0		0.01	0	0
19	1.0		0.02	2.0	0
20	1.0		1.3	3.4	7.8
21	3.1		0.7	3.4	15.6
22	2.1		1.4	3.9	28.1
23	7.2		6.7	5.4	48.5
24	6.2		6.0	4.9	68.8
25	2.1		8.7	7.9	61.0
26	6.2		12.0	6.9	67.2
27	22.8		19.2	14.3	36.0
28	28.1		29.6	28.1	37.5
29	49.9		38.3	50.7	21.9

30	36.9	46.1	72.9	26.6
31	25.0	49.3	62.1	12.5
32	31.2	38.1	45.3	12.5
33	26.9	39.4	28.1	6.3
34	28.7	21.7	22.7	6.3
35	22.9	27.6	22.2	1.6
36	10.1	19.7	13.8	6.3
37	14.8	16.4	8.9	3.1
38	9.1	12.5	9.4	3.1
39	3.7	3.3	5.9	3.1
40	1.0	7.2	3.4	0
41	0	3.3	1.5	0
42	0	2.0	0.5	0
43	1.0	1.3	1.5	0
44	0	1.3	0.5	0
45	1.0	1.3	0.5	0
46	0	0.7	0	0
47	0	0	0.5	0
48	0	0	0	0
49	0	0	0	0
50	0	0	0	0
51	0	0	0	0
52	0	0	0	0
53	0	0.7	0	0

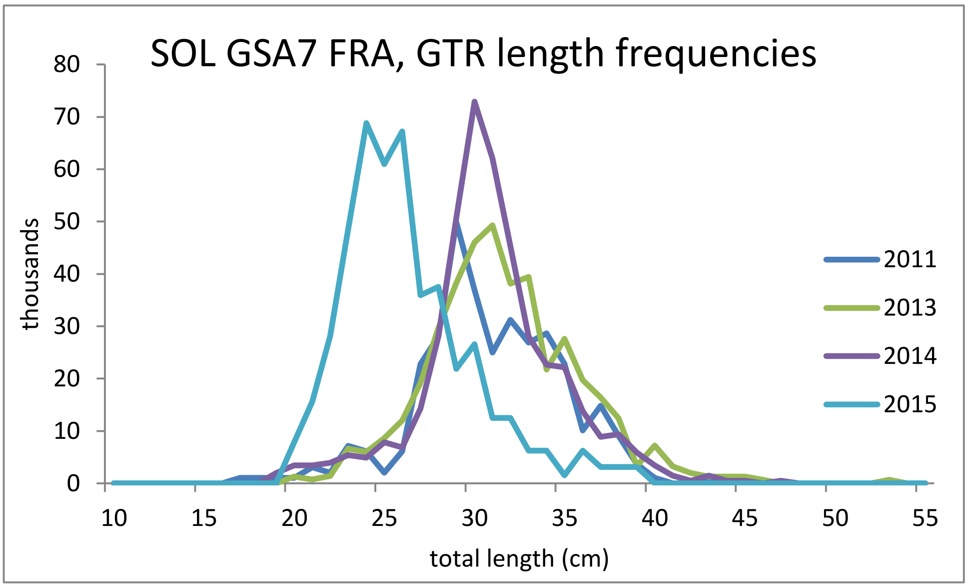


Figure 6.16.1.2.5. Common sole GSA 7. FRA GTR length frequencies. Data are in thousands.

OTB length range is 12-50 cm, GNS length range is 10-46 and GTR length range is 17-53.

Gear combined (OTB+GNS+GTR) length frequency distributions are shown in the following table:

Table 6.16.1.2.8. Common sole GSA 7. FRA OTB+GNS+GTR length frequencies gear combined. Data are in thousands.

length (cm)	2011	2012	2013	2014	2015
10	0	0.84	0	0	0
11	0	0	0	0	0
12	0.37	1.97	0	0	0
13	0	0	0	0	0
14	0	2.53	0	0	0
15	0.37	0.84	0	0	0.30
16	0.37	0.56	0	0	0.41
17	2.13	366	0.3	0	0.85
18	2.20	111	0.42	0.02	1.48
19	3.59	626	1.45	2.37	2.35
20	3.51	3256	2.98	4.85	10.31
21	5.91	2796	5.13	4.85	18.52
22	4.18	4215	9.49	5.09	31.83
23	10.11	4388	14.67	6.92	53.33
24	10.97	4182	17.21	6.07	75.31
25	7.47	8114	22.67	9.39	68.29
26	13.38	9099	29.61	11.24	76.03
27	33.05	12607	37.37	20.27	46.74
28	40.42	15976	50.37	33.85	51.53
29	66.44	21798	68.96	62.07	36.36
30	56.35	23286	75.85	85.57	41.75
31	43.55	20298	74.26	75.64	26.10
32	45.36	17306	63.87	58.12	24.57
33	41.84	15860	60.89	38.01	18.17
34	41.16	14405	41.65	35.23	18.22
35	35.51	12979	48.88	32.65	12.92
36	22.00	11673	38.35	24.57	18.21
37	25.89	7407	30.91	19.24	10.56
38	16.09	5985	24.33	18.34	11.42
39	9.59	5480	12.06	12.21	8.36
40	6.26	4002	13.57	9.27	3.65
41	3.29	1319	7.38	4.53	1.25
42	1.57	2329	4.65	2.76	1.24
43	1.74	1150	3.01	2.48	0.64
44	1.04	444	1.83	0.95	0.23
45	1.20	176	2.01	1.13	0.19
46	0.19	241	0.66	0.07	0.28
47	0	0	0.12	1.08	0
48	0	92.42	0	0	0
49	0	0	0	0	0
50	0	0	0.12	0	0
51	0	0	0	0	0
52	0	0	0	0	0

53	0	0	0.66	0	0

In the case of GTR (the main gear), 2012 length frequency has not been provided. Also, OTB 2012 length frequency values are out of boundaries, and are much higher than other years, but catches are similar. Considering that there is not length frequency for GTR and OTB length frequency values are too high, 2012 has not been considered in the analysis. Attempts to obtain further information regarding the 2012 data during the meeting did not succeed.

Concerning age structure, there are no data available in the DCF.

Discards

There are no discards data no catches, no length frequencies, available for Common sole in GSA 7 in the DCF data.

Finally, catch and length frequency data used in the present analysis for Common Sole in the GSA7 are French data corresponding to 2011, 2013, 2014 and 2015 gear separately.

6.16.1.3 Fishing effort data

Fishing effort data corresponds to the total effort for GSA7. Data are separated by gear but not by species.

Data series available in the DCF correspond to the period 2004-2015 for Spanish fleet, and there are only French effort data in 2015. This is a critical lack of data because French fleet represents the 97% of the total effort in GSA7. During the EWG-16-17 has been submitted additional information about French fleets in the GSA7. Finally, the period with available data is 2012-2015.

The total fishing effort (GT*days at sea) by year is shown in the following Table and figure:

Table 6.16.1.3.1. GSA 7. Fishing effort (GT*days at sea) by year.

	ESP	FRA	ESP+FRA	%FRA
2004	376298			
2005	351062			
2006	337666			
2007	348066			
2008	350818			
2009	324513			
2010	297675			
2011	334699			
2012	284196	426551	710747	60.0
2013	265596	1069415	1335011	80.1
2014	282866	1223963	1506829	81.2
2015	289331	10841830	11131161	97.4

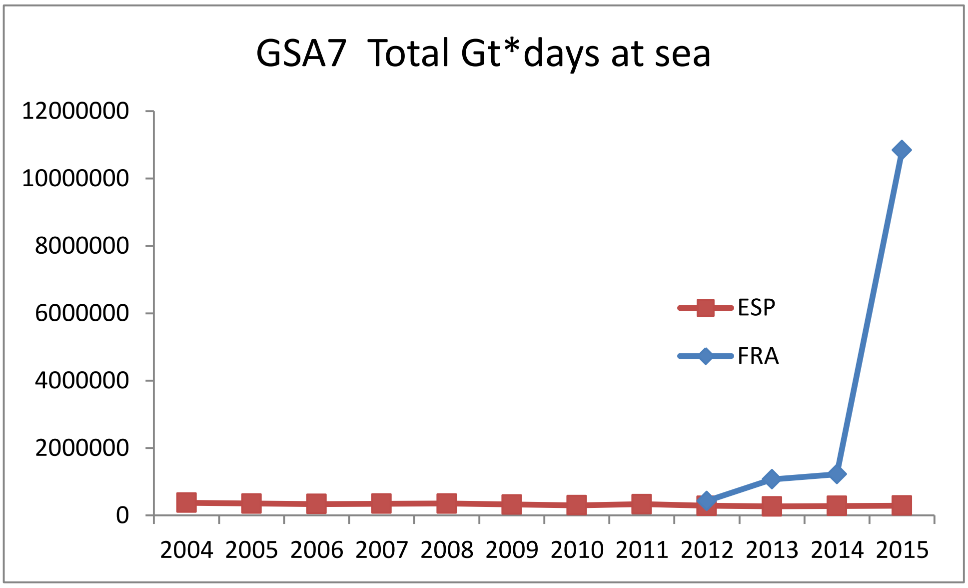


Figure 6.16.1.3.1. GSA 7. Fishing effort (GT*days at sea) by year.

Concerning the most important gears that catch Common sole (OTB, GNS, and GTR), the effort by year in GSA 7 is the following:

Table 6.16.1.3.2. GSA 7. Fishing effort (GT*days at sea) by year and main SOL gears.

	ESP-OTB	FRA- OTB	FRA-GNS	FRA-GTR
2004	322841			
2005	308926			
2006	308266			
2007	316488			
2008	322027			
2009	313450			
2010	275498			
2011	310191			
2012	268789		135974	124726
2013	248107	929623	4809	5224
2014	268090	847587	4397	7630
2015	276490	949262	2934287	3250503

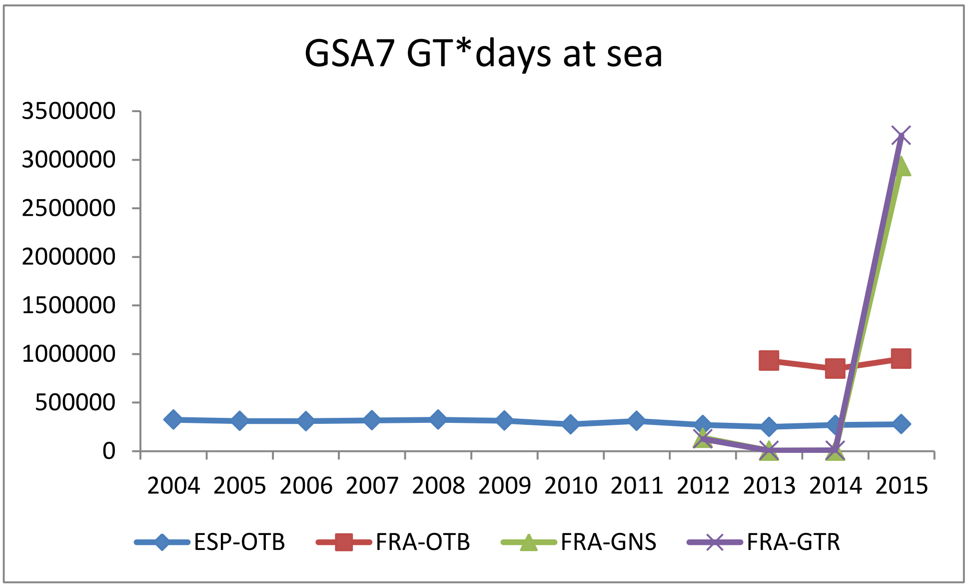


Figure 6.16.1.3.2. GSA 7. Fishing effort (GT*days at sea) by year and main SOL gears.

Total fishing effort in terms of Days at sea in GSA7 is provided from 2004 to 2015 by Spanish fleet but only for 2015 for French fleet.

Considering that information on fishing effort in GSA7 is very reduced and fragmented for the French fleets which are the most important in the GSA7, and also that 2015 GNS and GTR effort values have different scale compared with other years, EWG-16-17 cannot provide an effort evaluation for this area.

6.16.1.4 Survey Indices of abundance and biomass by year and size/age

Survey series data for Common sole (SOL) in GSA 7 are available from 1994 to 2012. However, there is not possible to calculate indices of abundance and biomass from the MEDITS surveys due to few individuals catch every year. In the Table is shown the total catch in number individuals (n) and weight (kg) by year in GSA7:

Table 6.16.1.4.1. Common sole GSA 7. MEDITS data, total catch number (n all hauls)) and weight (kg) by year.

year	SOL_number	SOL_weight (kg)
1994	28	6.8
1995	64	19.0
1996	45	9.5
1997	28	5.2
1998	9	4.2
1999	18	5.8
2000	13	2.4
2001	23	6.1
2002	30	7.1
2003	25	7.7
2004	17	4.8

2005	12	2.6
2006	19	4.7
2007	32	8.1
2008	25	7.2
2009	15	3.7
2010	10	3.1
2011	6	2.1
2012	47	5.8
2013	10	2.6
2014	9	2.6
2015	6	1.5

6.16.2 STOCK ASSESSMENT ON COMMON SOLE IN GSA 7

Method 1- VIT – Pseudocohort analysis

During EWG16-17 2011, 2013, 2014 and 2015 Common sole data in GSA 7 were assessed year separately, through pseudocohort analysis using VIT software (FAO, 1997; Lleonart and Salat, 1992).

Input data

The biological parameters used in the assessment are described in Section 6.16.1.1 and are the following:

Growth parameters used for VBGF were L_{inf} = 48.8, k = 0.24, t_0 = -0.77

Natural mortality (M) and maturity at age vectors:

	0	1	2	3	4	5+
M	0.46	0.19	0.14	0.12	0.1	0.1
Maturity	0.047	0.36	0.95	1	1	1

Catches by gear (t)

year	GNS	GTR	OTB	Total
2011	7.2	104.7	60.6	176.4
2013	36.8	128.7	67.2	248.6
2014	5.6	134.7	53.3	210.7
2015	16.5	98.2	51.4	184.1

Length frequencies by gear have been transformed to age frequencies by slicing using VIT software. Catch at age data used for pseudocohort analysis are in the following tables and figures. The analysis was carried out for the ages 0 to 5+ class. The most important gear that catches Common sole in GSA 7 is GTR. Age classes most caught are 1 to 4, while age class 0 is almost not caught (in 2013 and 2014 years, first age at catch is 1, while in 2011 and 2015 first age at catch is 0). Critical age in the catch is 3 in 2011, 2013 and 2014; while in 2015 critical age is 2.

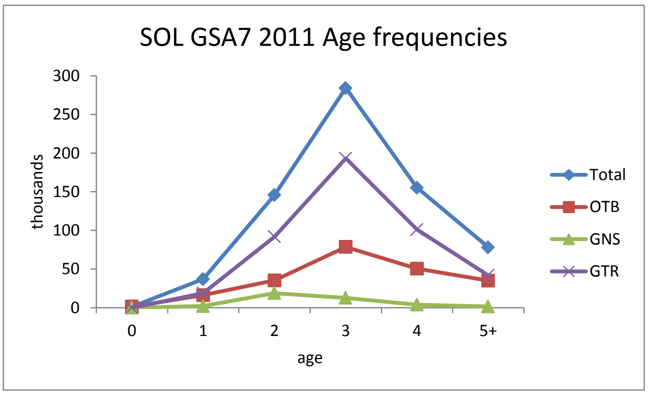
Catch numbers at age matrix (thousands) by gear

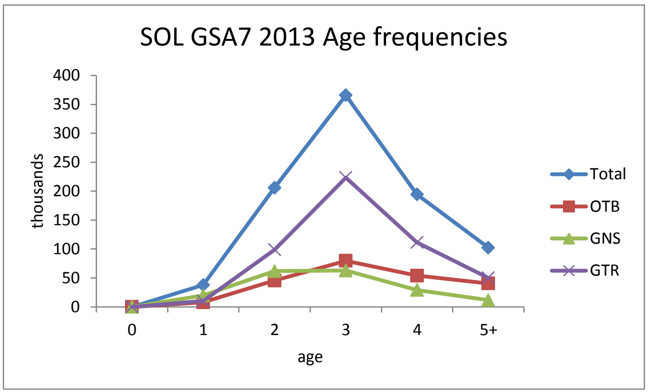
2011	Total	OTB	GNS	GTR
0	1.3	1.3	0.0	0.0
1	36.9	16.1	2.1	18.7
2	145.7	35.2	18.7	91.9
3	284.3	78.5	12.6	193.1
4	155.3	50.4	3.8	101.0
5+	78.1	35.0	1.4	41.7

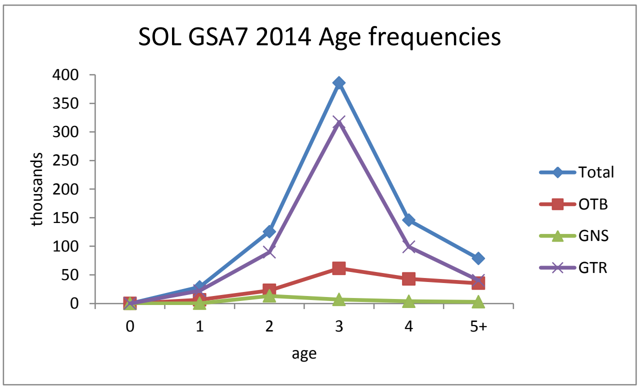
2013	Total	OTB	GNS	GTR
1	37.7	7.9	19.7	10.1
2	205.9	45.5	61.7	98.7
3	365.9	79.6	62.8	223.6
4	194.3	53.9	29.1	111.3
5+	102.2	40.6	11.5	50.2

2014	Total	OTB	GNS	GTR
1	28.9	6.4	0.3	22.2
2	125.5	22.8	13.2	89.6
3	385.9	61.4	6.9	317.6
4	145.6	42.8	3.8	99.0
5+	78.5	35.3	2.8	40.4

2015	Total	OTB	GNS	GTR
0	0.8	0.8	0.0	0.0
1	142.7	19.6	0.0	123.0
2	480.7	55.0	13.5	412.3
3	200.7	61.7	32.5	106.5
4	78.9	42.9	12.9	23.1
5+	53.8	28.6	7.9	17.3







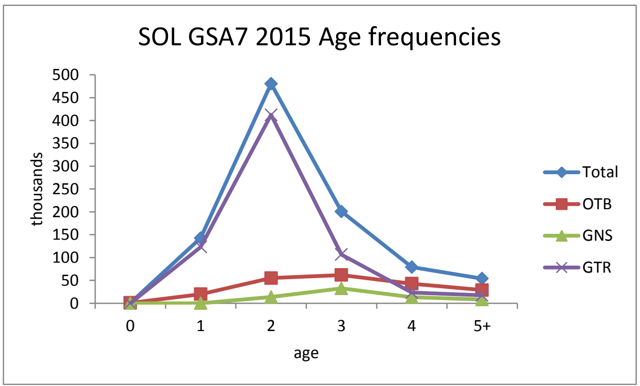


Figure 6.16.2.1. Common sole GSA 7. Catch at age data by gear used in VIT analysis (2011, 2013, 2014 and 2015). Data are in thousands.

Weights at age (kg)

Age/Years	0	1	2	3	4	5+
2011	0.004	0.034	0.094	0.175	0.263	0.352
2013		0.034	0.094	0.175	0.263	0.352
2014		0.034	0.094	0.175	0.263	0.352
2015	0.004	0.034	0.094	0.175	0.263	0.352

Different sensitivity trials were performed to fix terminal fishing mortality (Ft) value. Finally a value of Ft = 0.9 was adopted for the analyses (Figure 6.16.2.2).

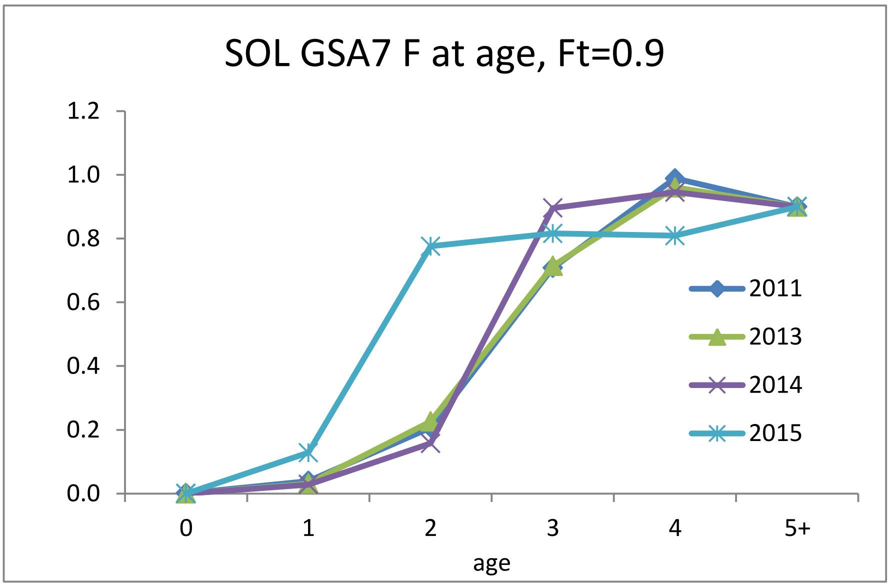


Figure 6.16.2.2. Common sole in GSA 7. Fishing mortality by age from VIT pseudo-cohort analysis (Ft = 0.9).

Results of assessment

VIT results for Assessment are presented in Tables 6.16.2.1 and 6.16.2.2 and Figure 6.16.2.3. These results show certain stability on catch and recruitment, fluctuation for Total Biomass and SSB values, and an increase in harvest in 2015.

Table 6.16.2.1 Common sole in GSA 7. Global VIT summary results.

	Stock number (thousands)	Stock biomass (tons)	Recruitment (thousands)	SSB (tons)	Fmean (1-4)
2011	4484	321.4	1665	279.9	0.49
2013	5560	406.2	1914	360.6	0.48
2014	4726	341.1	1634	302.5	0.51
2015	4894	266.6	2061	215.1	0.63

Table 6.16.2.2 Common sole in GSA 7. VIT summary results. Stock numbers at age and F at age by year.

Stock number (thousands)	2011	2012	2013	2014	2015
0	1665		1914	1634	2061
1	1050		1359	1148	1300
2	835		1089	923	946

3	590		756	686	379
4	258		328	248	148
5+	87		114	87	60

Total F 5+	2011	2012	2013	2014	2015
0	0.001		0	0	0
1	0.04		0.03	0.03	0.13
2	0.21		0.23	0.16	0.78
3	0.71		0.71	0.90	0.82
4	0.99		0.96	0.95	0.81
5+	0.90		0.90	0.90	0.90

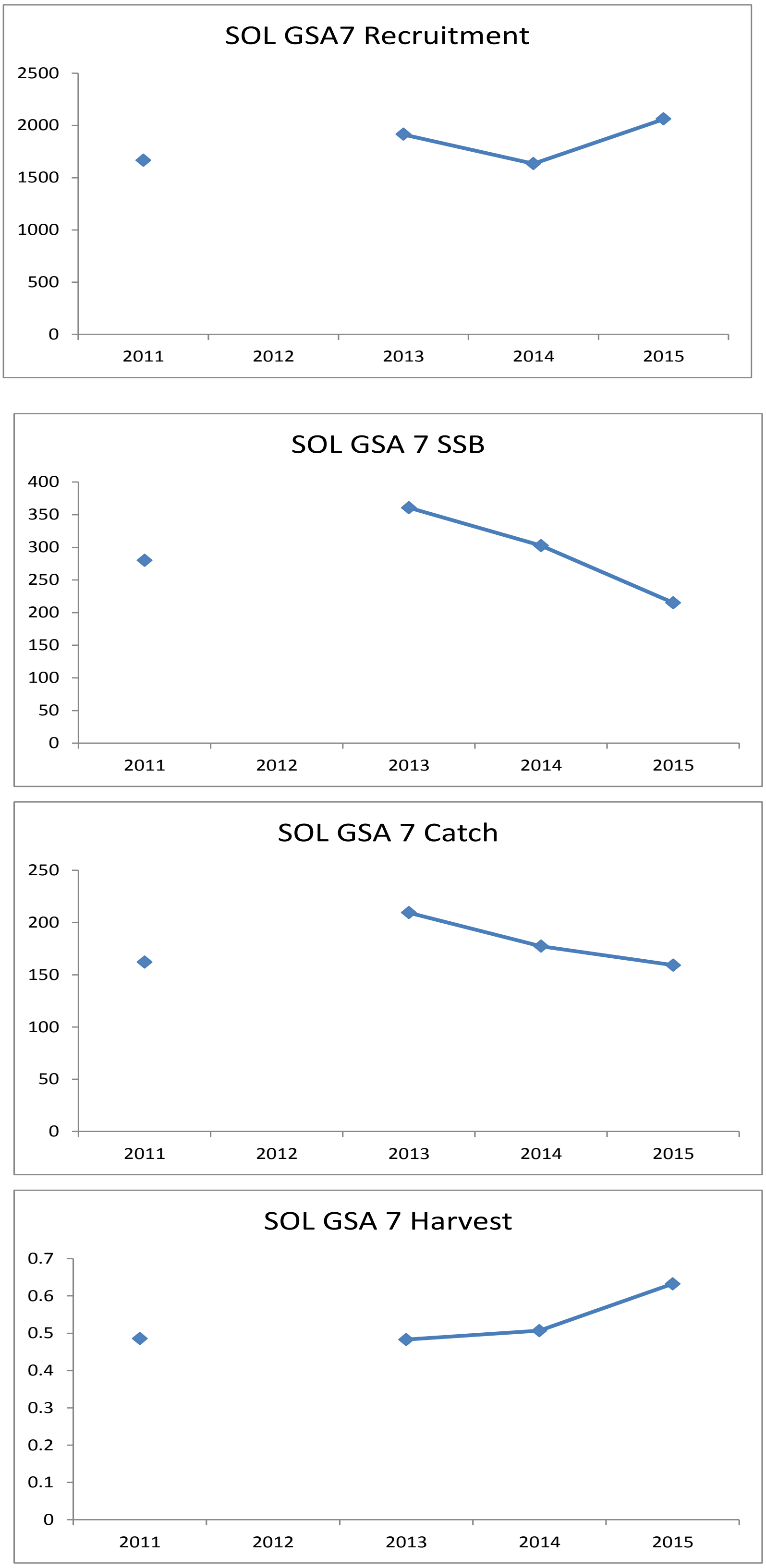


Figure 6.16.2.3 Common sole in GSA 7. VIT summary results. SSB and catch are in tons, recruitment in 1000s individuals.

A Yield per Recruit analysis for years 2011, 2013, 2014 and 2015 was conducted based on results obtained on pseudocohort analyses with VIT software.

Table 6.16.2.3 lists the results from the Y/R analysis and Figure 6.16.2.4 shows the Y/R curve when the actual level of exploitation /factor=1) is doubled (factor=2). The figure indicates signs of overexploitation. Lowest value of Y/R at current effort is observed in 2015.

Table 6.16.2.3. Common sole in GSA 7. Results of the Y/R analyses by year.

Y/R	2011	2013	2014	2015
Factor 0.1	136.0	215.5	214.8	125.0
Max (Y/R)	144.7	229.3	227.8	131.3
Factor 1 (current)	110.8	175.7	174.8	85.8
Factor 2	86.6	137.4	140.5	64.9
B/R	2011	2013	2014	2015
Factor 0.1	991.4	1553.8	1533.4	991.6
Max (Y/R)	620.1	965.2	973.1	645.7
Factor 1 (current)	219.1	328.0	321.1	144.6
Factor 2	135.4	195.2	198.3	78.8
SSB	2011	2013	2014	2015
Factor 0.1	954.6	1513.8	1493.5	955.414
Max (Y/R)	583.4	925.4	933.2	609.833
Factor 1 (current)	183.0	289.1	282.0	110.545
Factor 2	100.1	157.3	160.1	46.582

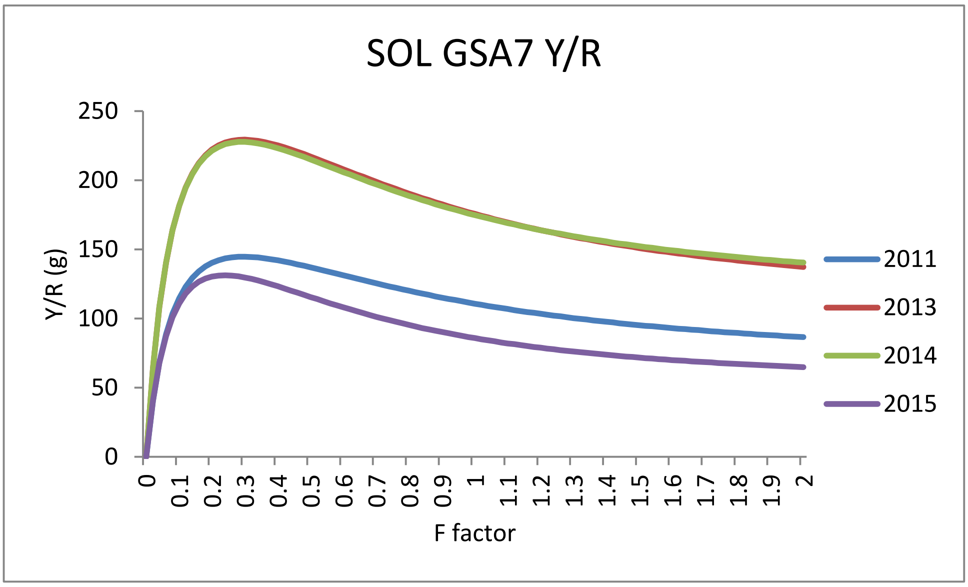


Figure 6.16.2.4. Common sole in GSA 7. Y/R by year in grams.

Method 2- Length indicator analysis

A length indicator analysis has been performed for Common sole in GSA 7. Results are shown in Figures 6.16.2.5 and 6.16.2.6 and show stability for this species in the indicators and a state around the optimum of exploitation. Linf was taken to be 48.8 cm.

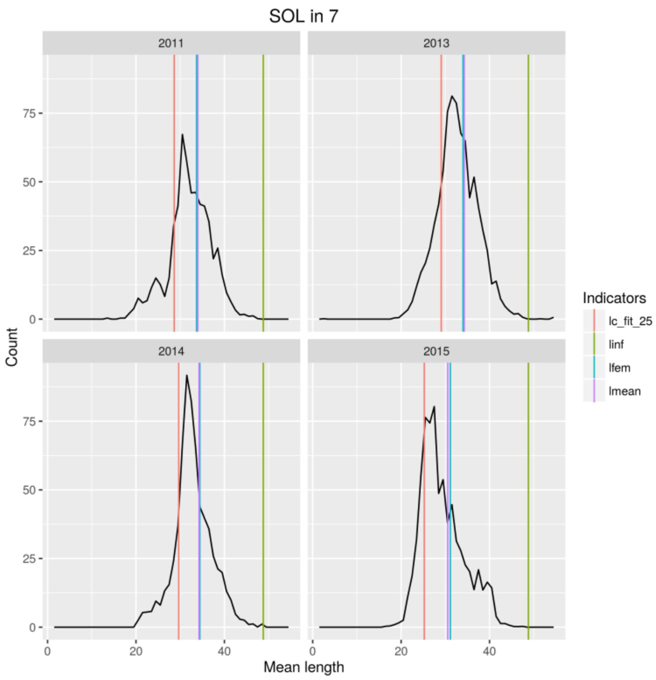


Figure 6.16.2.5. Common sole in GSA 7. Length indicators by year.

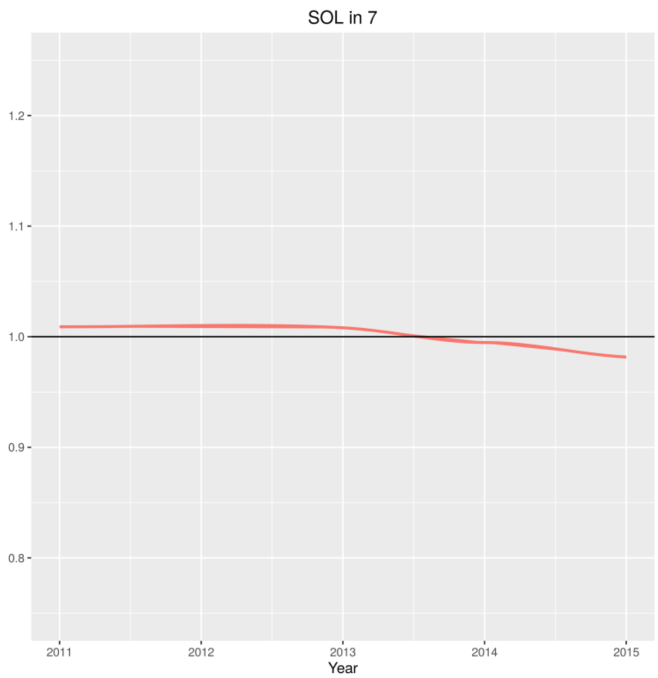


Figure 6.16.2.6. Common sole in GSA 7. Length indicators by year

6.16.3 REFERENCE POINT

A proxy of $F_{0.1}$ has been calculated as a relation between values of Fmean of the pseudocohort analyses and values of F0.1 factor of the Y/R analysis. Results are shown in the Table 6.16.3.1. Results show stability thorough the period analyzed, showing an $F_{0.1}$ value of 0.08-0.09.

Table 6.16.3.1. Common sole in GSA 7.

	2011	2013	2014	2015
F0.1 factor	0.17	0.17	0.17	0.15
Fmean (1-4)	0.49	0.48	0.51	0.63
F0.1	**0.08**	**0.08**	**0.09**	**0.09**

6.16.4 SHORT TERM FORECAST

No short term forecasts have been conducted during EWG-16-17 for Common sole in GSA 7.

Conclusions to assessment

Method 1 (VIT) gives stable results over 4 years in terms of F and F0.1 and indicates overexploitation for Common sole in GSA7. The level of overexploitation implies a reduction in F to 16% of current F. Whereas Method 2 (Length indicators) indicates that exploitation is around the optimum. The length indicator method is sensitive to assumptions, but the difference between the methods is much greater than would be expected, and bigger than that seen for any other stocks evaluated here. The length indicator may not account for precautionary considerations of biomass, whereas F0.1 use with the VIT analysis is known to be conservative, and even Fmax at around 0.2-0.3 is low and comparable with Fmsy for sole in more northerly waters. F on sole in GSA 7 is high relative to these values. Due to the shortage of data, and the short period analysed EWG-16-17 is not able to conclude about the appropriate exploitation level of this stock. Nevertheless is seems like that F should be reduced. It will be necessary to obtain a longer period of data to define the appropriate exploitation state of Common sole in GSA 7.

6.16.5 QUALITY AND PROPOSALS FOR FUTURE ASSESSMENTS

EWG16-17 has conducted pseudocohort analyses of Common sole in GSA 7 due to shorter data period available (4 years). It will not be possible in the future to conduct VPA analyses until the data period covers a continuous uninterrupted complete period of at least 6-7 years with coherent data from both countries involved in the fishery.

6.17 GILTHEAD SEABREAM IN GSA 7

6.17.1 DATA GATHERING OF GILTHEAD SEABREAM IN GSA 7

6.17.1.1 Stock Identity and Biology

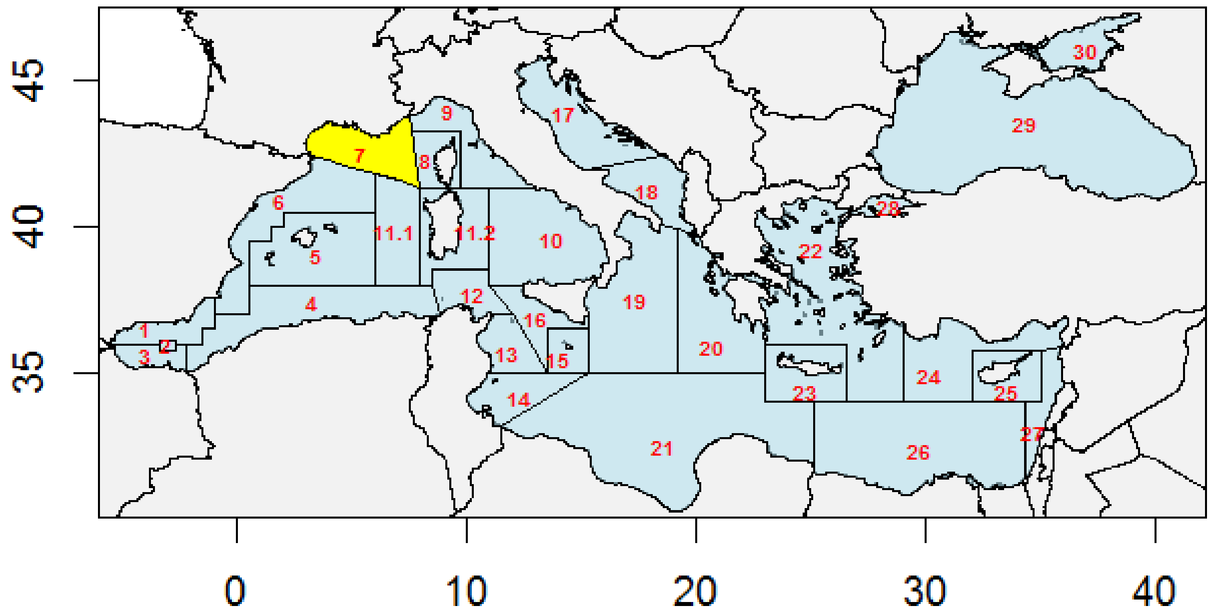


Figure 6.17.1.1. Geographical location of the GSA 7.

The picture on the genetic structure of the species is not clear (Triantafyllidis, 2007). Franchini *et al*. found (2012) low levels of population genetic structure in the gilthead sea bream, *Sparus aurata*, along the coast of Italy. Guinand *et al.* (2016) investigated patterns of genetic differentiation among seabream populations collected in coastal lagoons of the Gulf of Lions. Their results are consistent with the view that differential selection operates during early juvenile life in seabream and highlight the importance of temporal replication in studies of post-settlement selection in marine fish.

Gilthead seabream is one of the most important Sparids farmed in the Mediterranean. Information is available on genetic comparison of wild and cultivated European populations of the gilthead seabream. The existence of three genetically differentiated seabream populations along the Spanish coast showing all of them having high levels of genetic variability was demonstrated by García-Celdrán *et al.* (2016). According to Alarcón *et al* (2004), the high differentiation between cultivated and wild populations from the same area might indicate no evidence for significant genetic flow between them.

Gilthead seabream was not among the studied species in the frame of the STOCKMED project.

Biology

Sparus aurata is common in the Mediterranean Sea, present along the Eastern Atlantic coasts from Great Britain to Senegal, and rare in the Black Sea. Due to its euryhaline and eurythermal habits, the species is found in both marine and brackish water environments such as coastal lagoons and estuarine areas, in particular during the initial stages of its life cycle. Born in the open sea during October-December, juveniles typically migrate in early spring towards protected coastal waters, where they can find abundant trophic resources and milder temperatures. Very sensitive to low temperatures (lower lethal limit is 4 °C); in late autumn they return to the open sea, where the adult fish breed. In the open sea gilthead seabream are usually found on rocky

and seagrass (*Posidonia oceanica*) meadows, but it is also frequently caught on sandy grounds. Young fish remain in relatively shallow areas (up to 30 m), whereas adults can reach deeper waters, generally not more than 50 m. This species is a protandrous hermaphrodite. Sexual maturity develops in males at 2 years of age (20-30 cm) and in females at 2-3 years (33-40 cm). Females are batch spawners that can lay 20 000-80 000 eggs every day for a period up to 4 months. Traditionally, gilthead seabream were cultured extensively in coastal lagoons and saltwater ponds, until intensive rearing systems were developed during the 1980s. In captivity, sex reversal is conditioned by social and hormonal factors.
(http://www.fao.org/fishery/culturedspecies/Sparus_aurata/en).

Growth

Gilthead seabream is a protandrous hermaphrodite. In the DCF growth and length-weight relationship parameters are presented for both sexes combined. Table 6.17.1.1.1 allows comparison with Von Bertalanffy growth parameters estimated also for GSA 7 and other areas, both sexes combined. The set of and length-weight relationship parameters taken from Fishbase for GSA 7 were used for assessment. The reason for this choice was the very negative t_0 of the DCF parameters.

Table 6.17.1.1.1. Gilthead seabream in GSA 7. *Sparus aurata* growth and length-weight relationship parameters, both sexes combined.

	DCF GSA 7	Lagoon Algeria	Fishbase GSA 7	Fishbase Catalan Coast	Fishbase Sète	Cádiz	Orbetello lagoon	Mima stuary	Sète
Linf	76,8	55,33	75,97	62,2	53,9	84,6	60,7	59,8	62
k	0,102	0,513	0,13	0,17	0,26	0,13	0,33	0,15	0,221
t0	-2,83	-0,282	-1,22	-0,63	-0,28	-1,59	0	-1,71	-0,774

	DCF GSA 7	Fishbase GSA 7
a	0,014	0,0112
b	3,034	3,08

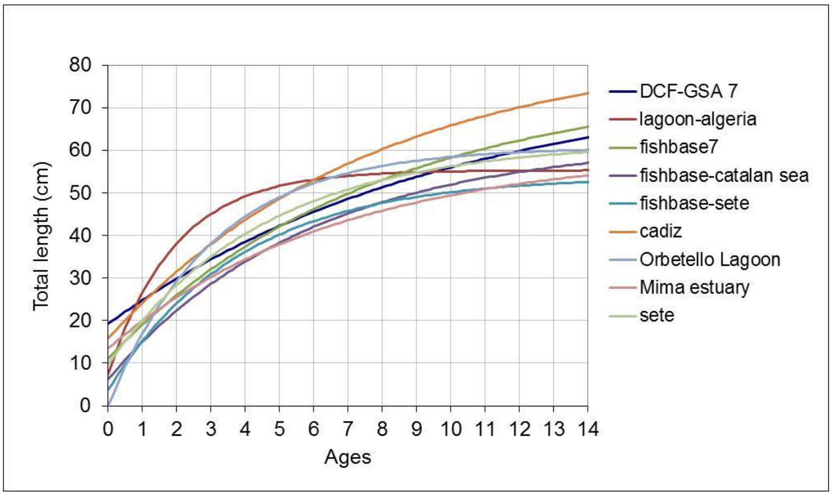


Figure 6.17.1.1.1. Gilthead seabream in GSA 7. *Sparus aurata* Von Bertalanffy growth curves in GSA 7 and other geographical areas.

Data sources: Chauoui *et al.* 2006 (Lagoon-Algeria); Campillo 1992 (Fishbase GSA 7); Suau and López 1976 (Fishbase-Catalan sea); in Fishbase with no reference (fishbase-sete); Arias 1981 (cadiz); pers. comm. Orbetello lagoon; Kraljevic and Dulcic 1997 (Mirna estuary); Lasserre and Labourg 1974 (sete).

Maturity

According to DCF (France) gilt seabream size at first maturity would be around 27 cm TL and at an age of 2 years. These values are given for both sexes combined. Regarding sex ratio, from 35 cm TL and age 4 females are dominant in the population; at age 3, sex ratio is 0.5.

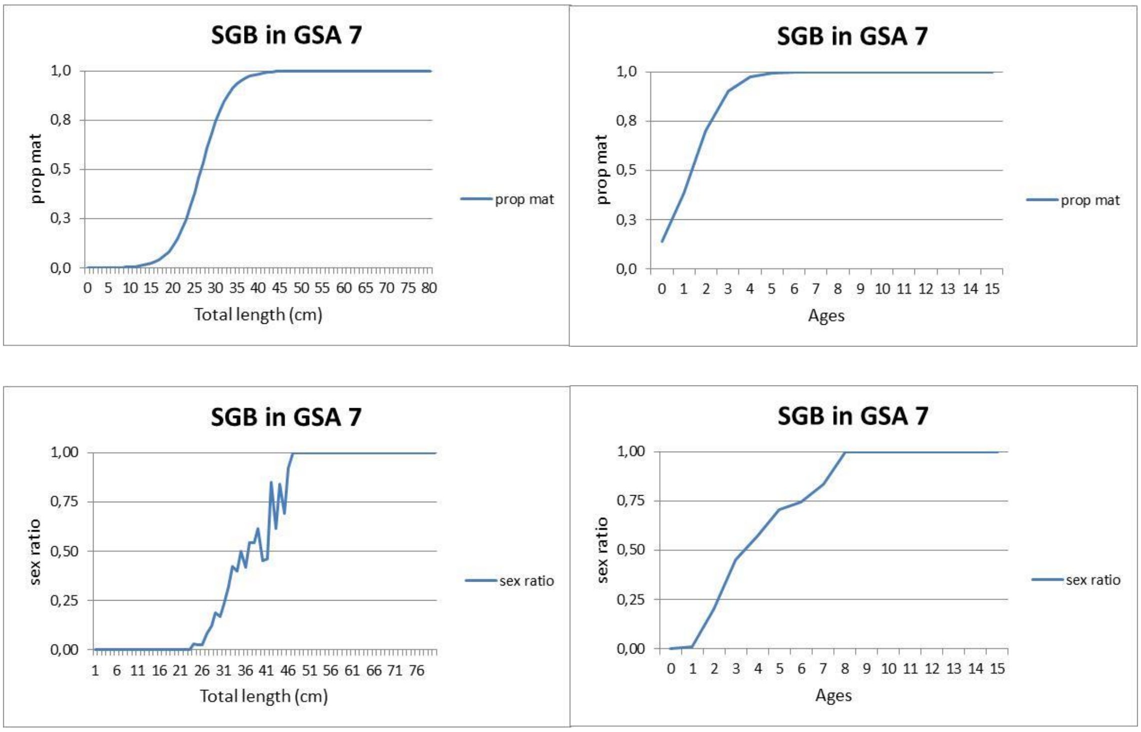


Figure6.17.1.1.2. Gilthead seabream in GSA 7. Length and age at first maturity, both sexes combined (upper panel) and sex ratio, by length and age (lower panel). Sex ratio indicates the proportion of females in the total number of sex determined individuals in each length or age class.

6.17.1.2 Catch data

LANDINGS

Gilthead seabream landings are produced by the French fishing fleets. Landings of the Spanish fleets operating in the Gulf of Lions are very small (<1% of the total).

Landings displayed an increasing trend starting in 2009, which could result from an improvement in reporting (GNS landings series started in 2009). Most of the landings correspond to GNS and OTB. A large variety of small-scale fishing gears reported small landings. Highest landings by far were obtained in 2015. It is worth noting the use of gear code "-1", with high landings in 2015.

Table 6.17.1.2.1. Gilthead seabream in GSA 7. Total annual landings (tonnes).

	SPAIN	FRANCE	TOTAL

2002	2.37	201.62	203.99
2003	6.16	287.17	293.33
2004	2.19	346.32	348.51
2005	3.84	260.05	263.89
2006	2.77	240.44	243.21
2007	4.64	129.60	134.24
2008	2.71	168.77	171.48
2009	1.41	868.06	869.47
2010	0.9	755.31	756.21
2011	1.47	943.04	944.51
2012	1.25	403.98	405.23
2013	2.89	907.02	909.91
2014	1.03	683.44	684.47
2015	2.16	1697.90	1700.06

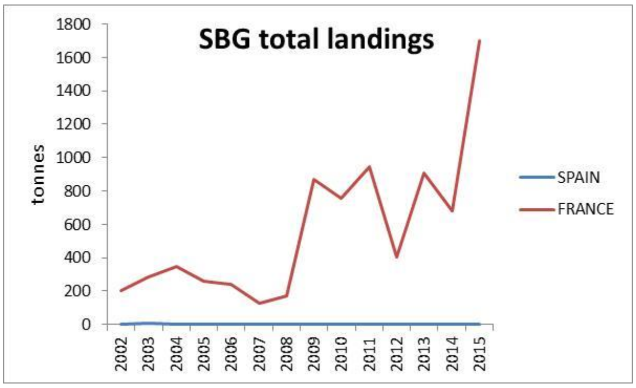


Fig.6.17.1.2.1. Gilthead seabream in GSA 7. Total annual landings (tonnes).

Table 6.17.1.2.2. Gilthead seabream in GSA 7- France. Total annual landings, by fishing gear (tonnes).

FRANCE	-1	DRB	FPO	FYK	GND	GNS	GTR	LHM	LHP
2002									
2003									
2004									
2005									
2006									
2007									
2008									
2009						627.44			
2010						375.16	262.28		
2011				37.75		746.71			
2012						327.65			
2013	11.75		23.59	86.90		526.37	108.58		1.10
2014	114.31	1.37	0.00	45.24		182.23	169.92		
2015	545.49	0.79	13.25	155.49	1.36	387.40	376.06	0.14	2.42

(cont)

	LLD	LLS	LTL	OTB	OTM	OTT	PS	SB	ALL GEARS
2002				201.62					201.62
2003				287.17					287.17
2004				346.32					346.32
2005				260.05					260.05
2006				240.44					240.44
2007				129.60					129.60
2008				168.77					168.77
2009				240.62					868.06
2010				117.87					755.31
2011		13.79		144.79					943.04
2012				76.33					403.98
2013		21.89		66.21			60.36	0.27	907.02
2014		14.07		134.48	11.02	4.26	6.52		683.44
2015	0.61	21.17	0.00	154.27	0.82	7.82	30.15	0.66	1697.90

Table 6.17.1.2.3. Gilthead seabream in GSA 7- Spain. Total annual landings, by fishing gear (tonnes).

SPAIN	GNS	GTR	LLS	OTB	ALL GEARS
2002	0.35	0.51	0.02	1.49	2.37
2003	0.96	0.67	0.05	4.48	6.16
2004	0.09	0.37	0.11	1.62	2.19
2005	0.13	0.98	0.06	2.67	3.84
2006	0.13	0.64	0.02	1.98	2.77
2007	0.73	0.46	0.23	3.22	4.64
2008	0.33	0.02	0.72	1.64	2.71
2009	0.07	0	0.3	1.04	1.41
2010	0.13	0.04	0.24	0.49	0.9
2011	0.29	0.03	0.51	0.64	1.47
2012	0.11	0.02	0.24	0.88	1.25
2013	0.21	0.07	0.48	2.13	2.89
2014	0.07	0.04	0.59	0.33	1.03
2015		0.15	0.78	1.23	2.16

LANDINGS/FISHING GEAR/YEAR/SIZE STRUCTURE

Table 6.17.1.2.4. Gilthead seabream in GSA 7- France. Size structure of the landings, by gear and year (thousands).

	gear -1				gear DRB		gear FPO		gear FYK		
	2013	2014	2015		2015		2013		2011	2013	2015
10				10		10		10			
11				11		11		11			
12				12		12		12			
13				13		13		13			
14				14		14		14			
15				15		15		15			
16				16		16		16			
17				17		17		17			
18				18		18		18			
19	0.040			19		19	0.090	19		0.310	
20	0.340	0.001		20		20	0.680	20		2.500	
21	0.800	0.001	2.710	21	0.004	21	1.610	21	1.119	5.950	0.773
22	0.930	0.001	12.197	22	0.018	22	1.870	22	3.357	6.890	3.477
23	0.890	0.002	46.079	23	0.066	23	1.780	23	11.189	6.570	13.135
24	1.350	0.002	111.133	24	0.160	24	2.720	24	32.447	10.020	31.677
25	1.820	0.003	128.752	25	0.185	25	3.650	25	34.684	13.460	36.699
26	2.370	0.002	105.712	26	0.152	26	4.770	26	16.783	17.530	30.132
27	3.170	0.001	56.923	27	0.082	27	6.380	27	4.475	23.480	16.225
28	3.050	0.000	29.815	28	0.043	28	6.120	28	4.475	22.540	8.499
29	2.030	0.000	43.368	29	0.062	29	4.080	29		15.030	12.362
30	2.580	0.000	37.948	30	0.055	30	5.190	30		19.100	10.817
31	1.650	0.000	31.171	31	0.045	31	3.310	31	1.119	12.210	8.885
32	1.740	0.000	32.527	32	0.047	32	3.480	32	1.119	12.830	9.272
33	1.020	0.000	27.105	33	0.039	33	2.040	33	1.119	7.510	7.727
34	1.230	0.000	8.131	34	0.012	34	2.460	34	2.238	9.080	2.318
35	0.760	0.000	14.908	35	0.021	35	1.530	35	2.238	5.640	4.250
36	0.590	0.000	13.553	36	0.020	36	1.190	36	1.119	4.380	3.863
37	0.470	0.000	13.553	37	0.020	37	0.930	37	1.119	3.440	3.863
38	0.420	0.000	6.777	38	0.010	38	0.850	38		3.130	1.932
39	0.420	0.000	2.710	39	0.004	39	0.850	39		3.130	0.773
40	0.340	0.000	5.421	40	0.008	40	0.680	40		2.500	1.545
41	0.340	0.000	4.066	41	0.006	41	0.680	41		2.500	1.159
42	0.040	0.000	5.421	42	0.008	42	0.090	42		0.310	1.545
43	0.130	0.000	1.356	43	0.002	43	0.260	43		0.940	0.387
44	0.090	0.000	6.777	44	0.010	44	0.170	44		0.630	1.932
45	0.090	0.000	6.777	45	0.010	45	0.170	45		0.630	1.932
46	0.040	0.000	4.066	46	0.006	46	0.090	46		0.310	1.159
47	0.040	0.000	4.066	47	0.006	47	0.090	47		0.310	1.159
48		0.000	0.000	48		48	0.000	48			0.000
49		0.000	0.000	49		49	0.000	49			0.000
50		0.000	1.356	50	0.002	50	0.000	50			0.387
51	0.040	0.000	2.710	51	0.004	51	0.090	51	1.119	0.310	0.773
52		0.000	1.356	52	0.002	52	0.000	52			0.387
53	0.040	0.000	1.356	53	0.002	53	0.090	53		0.310	0.387
54	0.040	0.000	0.000	54		54	0.090	54		0.310	0.000
55	0.040	0.000	0.000	55		55	0.090	55		0.310	0.000
56		0.000	0.000	56		56		56			0.000
57		0.000	0.000	57		57		57	1.119		0.000
58		0.000	0.000	58		58		58			0.000
59		0.000	0.000	59		59		59			0.000
60		0.000	0.000	60		60		60			0.000
61			1.356	61	0.002	61		61			0.387
62			0.000	62		62		62			0.000
63			0.000	63		63		63			0.000
64			0.000	64		64		64			0.000
65			1.356	65	0.002	65		65			0.387
66				66		66		66			
67				67		67		67			
68				68		68		68			
69				69		69		69			
70				70		70		70			
71				71		71		71			
72				72		72		72			
73				73		73		73			
74				74		74		74			
75				75		75		75			

Table 6.17.1.2.4 Gilthead seabream in GSA 7- France. Size structure of the landings, by gear and year (cont.)

Table 6.17.1.2.4. Gilthead seabream in GSA 7- France. Size structure of the landings, by gear and year (cont.)

gear GND		gear GNS							
	2013		2009	2010	2011	2012	2013	2014	2015
10		10							
11		11							
12		12							
13		13			0.984				
14		14							
15		15			0.984	0.342			
16		16			2.105	1.711			
17		17				1.369			
18		18				0.342			
19		19	0.003	0.002	0.567	0.676		0.366	
20		20	0.014	0.007	5.366	1.304		0.549	0.491
21	0.007	21	0.028	0.026	7.044	6.638	0.140	1.829	2.945
22	0.030	22	0.063	0.057	50.289	29.490	1.020	2.744	13.254
23	0.115	23	0.066	0.154	108.930	39.774	6.540	9.146	25.034
24	0.278	24	0.103	0.328	236.800	60.013	20.660	12.988	46.140
25	0.322	25	0.122	0.406	300.786	110.689	38.560	16.829	62.830
26	0.264	26	0.109	0.360	304.484	126.594	49.560	23.232	64.794
27	0.142	27	0.086	0.221	389.602	116.431	40.950	27.074	58.412
28	0.075	28	0.072	0.120	195.387	105.651	43.670	21.036	29.942
29	0.108	29	0.118	0.105	174.288	67.256	37.580	17.926	20.125
30	0.095	30	0.122	0.088	103.528	54.266	39.290	20.671	15.708
31	0.078	31	0.143	0.076	91.150	36.114	36.950	19.025	15.708
32	0.081	32	0.110	0.075	49.387	30.249	33.640	13.171	8.345
33	0.068	33	0.107	0.039	41.651	20.181	24.300	10.244	13.254
34	0.020	34	0.078	0.032	24.019	20.066	19.600	5.670	5.891
35	0.037	35	0.051	0.046	24.480	13.953	15.660	4.573	5.891
36	0.034	36	0.025	0.041	21.435	11.010	14.850	2.561	5.891
37	0.034	37	0.028	0.035	17.997	7.935	11.960	2.926	6.381
38	0.017	38	0.027	0.020	9.816	9.625	9.990	2.195	9.327
39	0.007	39	0.014	0.029	11.408	7.010	5.710	2.378	6.381
40	0.014	40	0.022	0.003	11.503	5.268	7.530	2.195	5.399
41	0.010	41	0.020	0.006	8.587	4.259	5.290	1.281	2.945
42	0.014	42	0.003	0.001	0.292	2.683	1.840	0.549	4.909
43	0.003	43	0.009	0.019	0.560	2.946	3.050	0.366	4.909
44	0.017	44	0.002	0.002		3.974	1.660	0.366	1.472
45	0.017	45	0.006	0.003	2.529	2.309	1.100	0.366	3.926
46	0.010	46	0.005	0.003		1.989	1.500	0.732	4.418
47	0.010	47	0.001	0.002	7.137	0.348	1.870	0.183	0.491
48		48	0.003	0.001	0.560	1.704	0.880	0.183	3.926
49		49	0.003	0.001	2.223	0.987	0.910	0.366	1.964
50	0.003	50	0.002	0.001	7.137	0.974	0.570	0.366	0.491
51	0.007	51	0.002	0.000	5.206	0.314	0.140	0.000	0.491
52	0.003	52	0.002	0.001	1.931	0.641	0.140	0.183	0.000
53	0.003	53			2.915		0.280	0.000	0.982
54		54			0.947	0.327	0.000	0.183	0.491
55		55				0.321	0.000	0.000	0.491
56		56			0.984		0.340	0.000	0.000
57		57					0.140	0.549	0.491
58		58			0.984		0.200	0.366	0.000
59		59					0.000	0.183	0.000
60		60					0.000	0.183	0.000
61	0.003	61					0.000	0.000	0.000
62		62					0.000	0.000	0.000
63		63					0.140	0.183	0.000
64		64					0.000	0.183	0.000
65	0.003	65			0.984		0.000	0.549	
66		66					0.000	0.000	
67		67					0.000	0.000	
68		68					0.000	0.000	
69		69					0.000	0.000	
70		70					0.000	0.000	
71		71					0.000	0.000	
72		72						0.000	
73		73							
74		74							
75		75							

Table 6.17.1.2.4. Gilthead seabream in GSA 7- France. Size structure of the landings, by gear and year (cont.)

	gear GTR					gear LHM		gear LHP			gear LLD
	2010	2013	2014	2015		2015		2013	2015		2015
10					10		10			10	
11					11		11			11	
12					12		12			12	
13					13		13			13	
14					14		14			14	
15					15		15			15	
16					16		16			16	
17				0.412	17		17			17	
18				1.236	18		18			18	
19	0.001			1.648	19		19			19	
20	0.001			2.884	20		20	0.03		20	
21	0.004		0.595	13.184	21	0.001	21	0.08	0.012	21	0.004
22	0.006		2.378	18.952	22	0.003	22	0.09	0.054	22	0.014
23	0.016938		4.757	14.42	23	0.012	23	0.08	0.204	23	0.052
24	0.015837	0.150	4.163	32.96	24	0.029	24	0.13	0.493	24	0.125
25	0.020757	0.250	8.92	54.384	25	0.034	25	0.17	0.571	25	0.145
26	0.055101	1.130	19.029	57.269	26	0.028	26	0.22	0.47	26	0.119
27	0.035736	2.530	32.707	44.497	27	0.015	27	0.3	0.252	27	0.064
28	0.030859	2.150	25.57	42.024	28	0.008	28	0.29	0.132	28	0.034
29	0.029981	1.670	20.814	32.549	29	0.011	29	0.19	0.193	29	0.049
30	0.021045	2.270	20.814	23.897	30	0.010	30	0.24	0.168	30	0.043
31	0.022723	1.820	11.893	20.6	31	0.008	31	0.16	0.138	31	0.035
32	0.037725	1.680	4.757	19.365	32	0.009	32	0.16	0.145	32	0.036
33	0.0423	1.990	10.704	19.776	33	0.007	33	0.1	0.12	33	0.030
34	0.020871	1.090	6.541	21.012	34	0.002	34	0.12	0.036	34	0.010
35	0.013258	1.150	7.136	10.301	35	0.004	35	0.07	0.067	35	0.016
36	0.021914	0.730	4.757	11.949	36	0.004	36	0.06	0.06	36	0.016
37	0.015043	0.940	2.378	9.064	37	0.004	37	0.04	0.06	37	0.016
38	0.015362	0.610	2.974	7.416	38	0.002	38	0.04	0.03	38	0.008
39		0.690	2.378	4.533	39	0.001	39	0.04	0.012	39	0.004
40	0.001	0.630	1.189	7.828	40	0.001	40	0.03	0.024	40	0.006
41		0.230	1.189	3.709	41	0.001	41	0.03	0.018	41	0.004
42		0	0.595	2.472	42	0.001	42		0.024	42	0.006
43		0.150	0	0.824	43	0	43	0.01	0.006	43	0.002
44	0.002001	0.150	1.189	0.412	44	0.002	44	0.01	0.03	44	0.008
45		0.150	0	1.648	45	0.002	45	0.01	0.03	45	0.008
46		0.250	0.595	0.824	46	0.001	46		0.018	46	0.004
47		0.080	0	0.412	47	0.001	47		0.018	47	0.004
48	0.001	0.080	0	0.412	48		48		0	48	0
49		0.150	1.784	0.412	49		49		0	49	0
50		0.310	0	0.412	50	0	50		0.006	50	0.002
51		0.150	0	0.412	51	0.001	51		0.012	51	0.004
52		0.080	0	0	52	0	52		0.006	52	0.002
53		0.080	0	0	53	0	53		0.006	53	0.002
54		0.150	0	0	54		54		0	54	0
55		0	0	0	55		55		0	55	0
56		0.080	0	0	56		56		0	56	0
57		0	0	0	57		57		0	57	0
58		0	0	0	58		58		0	58	0
59		0	0.595	0	59		59		0	59	0
60		0	0	0	60		60		0	60	0
61		0	0	0	61	0	61		0.006	61	0.002
62		0	0	0	62		62		0	62	0
63		0	0	0	63		63		0	63	0
64		0	0	0	64		64		0	64	0
65		0	0.595	0	65	0	65		0.006	65	0.002
66		0	0	0	66		66		0	66	0
67		0	0	0	67		67		0	67	0
68		0	0	0	68		68		0	68	0
69		0			69		69		0	69	0
70		0			70		70		0	70	0
71		0			71		71			71	0
72		0			72		72			72	0
73					73		73			73	
74					74		74			74	
75					75		75			75	

Table 6.17.1.2.4. Gilthead seabream in GSA 7- France. Size structure of the landings, by gear and year (cont.)

	gear LLS				gear OTB						
	2011	2013	2015		2002	2003	2004	2005	2006	2007	2008
10				10	0	0	0	0	0	0	0
11				11	0	0	0	0	0	0	0
12				12	0	8.442	0	0	0	0	0
13				13	1.241	10.971	0	0	0	0.574	0
14				14	2.068	54.444	28.999	0	0	1.806	0
15				15	26.257	73.241	108.024	8.819	0	2.391	5.305
16				16	50.288	95.822	144.409	7.408	20.461	29.933	47.751
17				17	240.193	128.463	111.569	28.398	87.997	129.602	126.359
18				18	201.085	185.046	169.066	38.829	96.921	155.786	174.919
19		0.080		19	136.666	147.068	266.572	75.493	65.969	143.045	129.917
20		0.630		20	10.200	115.475	177.112	54.038	73.779	95.224	50.096
21		1.500	0.105	21	19.276	83.864	82.206	15.632	19.088	31.639	22.048
22		1.740	0.473	22	0.226	96.375	124.985	13.631	16.101	16.101	21.160
23	1.707	1.660	1.789	23	0.247	141.840	121.107	32.099	44.707	44.707	34.928
24		2.520	4.312	24	1.412	169.060	135.060	81.972	116.710	116.710	56.792
25		3.390	4.996	25	4.134	178.654	174.118	90.912	112.196	117.987	45.384
26		4.420	4.103	26	12.168	108.772	120.147	89.886	76.189	105.144	30.189
27		5.910	2.209	27	35.661	38.073	54.349	56.227	33.683	88.331	22.263
28		5.680	1.158	28	33.043	17.472	44.883	33.773	25.098	73.734	28.219
29		3.790	1.683	29	21.111	9.094	51.989	39.292	18.499	62.709	28.487
30		4.810	1.473	30	9.907	8.871	18.707	48.227	21.991	36.995	20.958
31		3.080	1.21	31	5.589	7.050	26.628	22.165	21.735	34.639	16.196
32		3.230	1.262	32	1.963	2.901	10.919	20.791	14.294	18.655	19.491
33	0.853	1.890	1.052	33	3.128	1.394	7.898	28.833	26.833	29.014	12.482
34		2.290	0.316	34	3.045	5.014	9.476	50.377	19.000	19.916	1.995
35		1.420	0.579	35	2.038	3.512	8.679	5.604	9.197	16.247	5.308
36	0.853	1.100	0.526	36	2.705	2.295	3.011	10.233	10.607	21.183	1.389
37	0.853	0.870	0.526	37	2.862	2.858	3.489	4.651	4.253	5.169	3.908
38	0.853	0.790	0.263	38	3.604	1.713	1.680	2.769	7.884	8.800	2.319
39		0.790	0.105	39	3.051	1.949	1.089	1.044	1.427	5.869	3.353
40		0.630	0.211	40	6.597	2.908	2.185	1.927	5.085	6.001	0.348
41		0.630	0.157	41	1.839	1.972	0.148	0.930	5.902	5.902	0.774
42		0.080	0.211	42	1.391	0.512	0	1.229	1.117	1.117	0.896
43		0.240	0.052	43	0.783	0.413	0.664329	0.871	2.096	2.096	0.466
44		0.160	0.263	44	2.058	0.503	0.153986	0.739	1.117	1.117	0.894
45		0.160	0.263	45	2.507	0.817	0.443604	0.176	0	0	0.410
46		0.080	0.157	46	0.510	0.426	0.074856	0.179	0.310	0.310	0.003
47		0.080	0.157	47	1.231	0.341	0.076994	0	0	0	0.438
48			0	48	4.554	0.220	0	0.133	0	0.773	0.814
49			0	49	3.657	0.323	0	0.366	0	0.773	0
50			0.052	50	6.643	0.328	0.146816	0.398	0	0	0.526
51		0.080	0.105	51	0.204	0.109	0.074856	0	0.201	0.964	0.421
52			0.052	52	2.334	0.223	0.07196	0.134	0	0	0.876
53	1.707	0.080	0.052	53	4.669	0.213	0	0	0	0.773	0.053
54	0.853	0.080	0	54	2.138	0.560	0	0	0	0.764	0
55		0.080	0	55	1.628	0.192	0.067737	0	0	0.850	0
56	1.707		0	56	4.159	0.341	0	0	0	0	0
57			0	57	1.628	0.108	0.40901	0	0.201	0.201	0
58			0	58	0.608	0	0	0	0	0	0
59			0	59	1.216	0.206	0.07196	0	0	0	0
60			0	60	1.118	0.246	0	0.152	0	0	0
61			0.052	61	1.216	0	0	0.134	0	0	0.001
62			0	62	0	0.148	0.074534	0	0	0.850	0
63			0	63	0	0.189	0.127013	0	0	0.768	0
64			0	64	0.510	0	0	0	0	0	0
65			0.052	65	0	0.196	0	0	0	0	0
66			0	66	0	0.102	0.074534	0	0	0	0
67			0	67	0	0	0	0	0	0	0
68			0	68	0	0.110	0	0	0	0	0
69			0	69	0	0	0	0	0	0	0
70			0	70	0	0	0	0	0	0	0
71				71	0	0	0	0	0	0	0
72				72	0	0	0	0.152	0	0	0
73				73							
74				74							
75				75							

Table 6.17.1.2.4. Gilthead seabream in GSA 7- France. Size structure of the landings, by gear and year (cont.)

	gear OTB							gear OTM		
	2009	2010	2011	2012	2013	2014	2015		2014	2015
10	0	0	0		0	0	0	10	0	0
11	0	0	0		0	0	0	11	0	0
12	0	7.664	1.336		1.336	0	0	12	0	0
13	0	22.116	17.706		17.706	3.432	1.213	13	0.281	0
14	0	52.240	66.348		66.348	8.582	2.829	14	0.703	0
15	5.157	107.386	81.950	1.627	81.950	12.015	8.085	15	0.984	0.054
16	16.658	132.123	83.239	4.886	83.239	13.731	14.01	16	1.125	0.094
17	26.297	122.565	39.558	13.019	39.558	8.673	32.935	17	0.711	0.262
18	26.585	82.717	9.978	9.765	9.978	8.763	74.022	18	0.718	0.525
19	70.314	40.174	0.902	10.296	0.902	16.02	80.647	19	1.313	0.523
20	86.022	38.507	4.908	7.587	4.908	28.237	84.707	20	2.314	0.481
21	88.246	29.190	8.977	11.32	8.977	39.68	74.546	21	3.251	0.275
22	109.093	57.693	44.017	29.277	44.017	51.525	49.24	22	4.224	0.199
23	59.718	66.330	78.381	74.683	78.381	86.613	74.785	23	7.099	0.356
24	73.707	40.242	97.785	71.703	97.785	96.082	81.343	24	7.875	0.538
25	63.404	31.494	77.657	58.658	77.657	84.364	71.624	25	6.914	0.468
26	66.628	20.102	44.531	23.887	44.531	73.957	57.948	26	6.061	0.336
27	45.600	13.414	19.917	25.585	19.917	41.292	57.97	27	3.384	0.27
28	27.857	11.916	29.263	12.912	29.263	28.947	33.827	28	2.372	0.148
29	29.731	7.008	18.478	7.383	18.478	13.454	22.745	29	1.103	0.117
30	36.426	3.621	8.465	3.971	8.465	5.717	8.264	30	0.47	0.047
31	32.652	4.194	8.401	2.335	8.401	3.400	8.57	31	0.279	0.043
32	27.033	2.522	6.279	4.064	6.279	4.099	6.813	32	0.336	0.037
33	14.637	3.482	5.382	1.085	5.382	2.063	3.422	33	0.169	0.018
34	8.894	2.743	0.411	0.848	0.411	0.831	2.960	34	0.068	0.017
35	6.162	1.435	1.759		1.759	0.558	2.257	35	0.047	0.012
36	4.374	1.161	0.819	0.661	0.819	1.013	2.746	36	0.083	0.014
37	5.665	0.791	1.085		1.085	0.043	1.021	37	0.003	0.004
38	0.708	0.371	0.918		0.918	0.014	0.756	38	0.001	0.005
39	2.727	0.048	0.626		0.626	0.189	1.122	39	0.015	0.005
40	1.845	0.094	1.793	0.209	1.793	0	0.638	40	0	0.002
41	1.438	0.176	0.228		0.228	0.014	0.108	41	0.001	0.001
42	1.373	0.064	0.634		0.634	0	0.326	42	0	0.002
43	0.478	0.307	0.228		0.228	0.412	0.433	43	0.035	0.002
44	0.975	0.366	0.630		0.630	0.160	0.183	44	0.013	0.002
45	0.802	0.328	1.331		1.331	0	0.342	45	0	0.001
46	0.569	0.133	0		0	0	0.001	46	0	0
47	0.846	0.063	0.370		0.370	0	0.001	47	0	0
48	0.712	0.113	1.331		1.331	0.014	0	48	0.001	0
49	0	0.410	0		0	0	0.074	49	0	0.001
50	0	0.094	0		0	0	0	50	0	0
51	0.412	0.031	0		0	0	0.001	51	0	0
52	1.951	0.027	0.176		0.176	0	0.292	52	0	0.002
53	0	0	0		0	0	0	53	0	0
54	0	0	0		0	0	0.107	54	0	0.001
55	0	0	0.184		0.184	0	0.217	55	0	0.001
56	0	0	0		0	0	0	56	0	0
57	0.412	0	0.990		0.990	0.146	0	57	0.012	0
58	0	0.031	0		0	0	0	58	0	0
59	0	0	0		0	0	0	59	0	0
60	0	0.048	0		0	0.383	0	60	0.032	0
61	0	0	0		0	0	0.077	61	0	0
62	0	0	0		0	0	0	62	0	0
63	0	0.031	0		0	0	0	63	0	0
64	0.410	0	0		0	0	0	64	0	0
65	0	0.018	0.166		0.166	0	0.074	65	0	0.001
66	0	0	0		0	0	0	66	0	0
67	0	0	0		0	0	0	67	0	0
68	0	0	0		0	0	0	68	0	0
69	0	0	0		0	0	0	69	0	0
70	0	0	0		0	0	0	70	0	0
71	0	0	0		0	0	0	71	0	0
72	0	0	0		0	0	0	72	0	0
73								73		
74								74		
75								75		

Table 6.17.1.2.4. Gilthead seabream in GSA 7- France. Size structure of the landings, by gear and year (cont.)

	gear LLS	
	2010	2015
10		
11		
12		
13		
14		
15		
16		
17		0.030
18		0
19		0.157
20		0.056
21		0
22		0.150
23		0.127
24		0.064
25		0.076
26	0.006	0.10
27		0.126
28		0.203
29		0.051
30		0.044
31		0.131
32	0.006	0.104
33		0.083
34	0.012	0.083
35	0.012	0.056
36		0.050
37	0.006	0.014
38		0.030
39		0.014
40		0.03
41		0
42		0
43		0.006
44	0.006	0
45		0
46		0.006
47	0.006	0.012
48	0.012	0
49		0.006
50	0.006	0.020
51	0.006	0
52		0
53		0
54		0
55		0.006
56	0.006	
57		
58		
59		
60		
61		
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75		

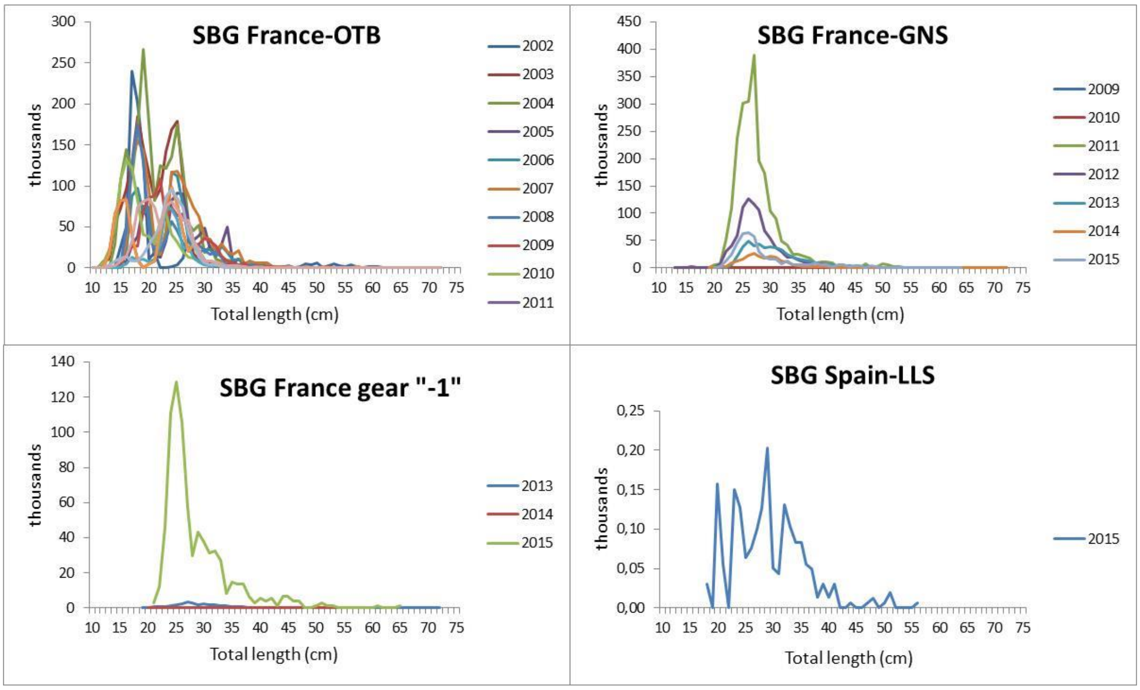

Figure 6.17.1.2.2. Gilthead seabream in GSA 7. Size structure of the main fishing gears, OTB-France, GNS-France and LLS-Spain; and the size structure of the non-identified fishing gear "-1". Note the different scale of y-axis.

LANDINGS/FISHING GEAR/YEAR/AGE STRUCTURE

Table 6.17.1.2.5. Gilthead seabream in GSA 7- France. Age structure of the landings, by gear and year (thousands).

	gear -1			gear DRB			gear FPO		
	2013	2014	2015		2014	2015		2014	2015
0	14.420	1.137	0	0	0.014	0	0	0	0
1	598.000	77.806	469.646	1	0.932	0.676	1	0.003	11.411
2	515.620	127.074	575.301	2	1.523	0.828	2	0.005	13.977
3	506.850	23.719	160.776	3	0.284	0.231	3	0.001	3.907
4	152.800	21.460	73.709	4	0.257	0.106	4	0.001	1.791
5	37.810	3.501	94.740	5	0.042	0.136	5	0	2.302
6	38.050	4.373	0	6	0.052	0	6	0	0
7	0	0	0	7	0	0	7	0	0
8	0	0	0	8	0	0	8	0	0
9	0	0	0	9	0	0	9	0	0
10	0	0	0	10	0	0	10	0	0
11	0	0	0	11	0	0	11	0	0
12	0	0	0	12	0	0	12	0	0

Table 6.17.1.2.5. Gilthead seabream in GSA 7- France. Age structure of the landings, by gear and year (thousands; cont.).

	gear FYK				gear GND		gear GNS				
	2011	2014	2015		2015		2009	2010	2011	2014	2015
0	0	0.449	0	0	0	0	0	1514.765	10.006	1.808	0
1	78.469	30.791	133.869	1	1.174	1	0	1642.289	844.603	124.027	333.535
2	30.899	50.293	163.985	2	1.438	2	0	0	1017.879	202.584	408.569
3	7.744	9.388	45.829	3	0.402	3	0	0	265.576	37.814	114.18
4	1.039	8.494	21.010	4	0.184	4	0	0	54.039	34.213	52.346
5	0.448	1.386	27.005	5	0.237	5	0	0	4.896	5.581	67.283
6	0	1.731	0	6	0	6	0	0	9.921	6.972	0
7	1.119	0	0	7	0	7	0	0	11.303	0	0
8	0	0	0	8	0	8	0	0	5.793	0	0
9	0	0	0	9	0	9	201.331	0	0.984	0	0
10	0	0	0	10	0	10	0	0	0	0	0
11	1.119	0	0	11	0	11	0	0	0	0	0
12	0	0	0	12	0	12	0	0	1.968	0	0

	gear GTR			gear LHM		gear LHP		gear LLD		gear LTL
	2014	2015		2015		2015		2015		2015
0	1.686	0	0	0	0	0	0	0	0	0
1	115.649	323.774	1	0.124	1	2.084	1	0.529	1	0.002
2	188.899	396.612	2	0.152	2	2.553	2	0.648	2	0.003
3	35.261	110.839	3	0.042	3	0.713	3	0.181	3	0.001
4	31.902	50.815	4	0.019	4	0.327	4	0.083	4	0
5	5.204	65.313	5	0.025	5	0.42	5	0.107	5	0
6	6.501	0	6	0	6	0	6	0	6	0
7	0	0	7	0	7	0	7	0	7	0
8	0	0	8	0	8	0	8	0	8	0
9	0	0	9	0	9	0	9	0	9	0
10	0	0	10	0	10	0	10	0	10	0
11	0	0	11	0	11	0	11	0	11	0
12	0	0	12	0	12	0	12	0	12	0

	gear OTB								
	2006	2007	2008	2009	2010	2011	2013	2014	2015
0	370.784	286.892	536.141	0.629	405.547	455.921	55.72	106.004	0
1	391.475	141.722	174.564	397.89	150.223	432.724	171.62	367.387	645.132
2	85.484	51.646	84.409	197.9	133.556	104.631	52.41	151.154	180.817
3	58.321	15.49	57.069	9.142	14.277	7.904	14.81	9.374	20.222
4	30.125	4.725	4.557	13.448	0.643	1.046	2.22	1.415	8.086
5	3.225	15.988	0	2.823	0.42	0.281	0.16	0.264	3.911
6	0.573	1.814	6.465	1.69	0.263	0.09	0.29	0.54	0
7	0	0	0.947	2.699	0.486	0.142	0	0	0
8	0.201	0	0	0.607	0.025	0.041	0	0	0
9	0	0	0	0	0	0.042	0	0	0
10	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0.067	0	0	0
12	0	0	0	0	0	0.038	0	0	0

	gear LLS				gear OTM			gear OTT			gear PS	
	2011	2014	2015		2014	2015		2014	2015		2014	2015
0	0	0.140	0	0	8.688	0	0	3.36	0	0	0.065	77.608
1	1.707	9.577	18.226	1	30.111	3.418	1	11.645	32.719	1	4.438	51.084
2	0	15.644	22.325	2	12.388	0.957	2	4.791	9.163	2	7.248	18.593
3	2.011	2.920	6.239	3	0.768	0.107	3	0.297	1.023	3	1.353	9.514
4	1.402	2.642	2.860	4	0.116	0.043	4	0.045	0.409	4	1.224	5.350
5	0	0.431	3.677	5	0.022	0.020	5	0.008	0.197	5	0.2	0
6	0	0.538	0	6	0.045	0	6	0.017	0	6	0.249	0
7	0	0	0	7	0	0	7	0	0	7	0	0
8	2.560	0	0	8	0	0	8	0	0	8	0	0
9	1.707	0	0	9	0	0	9	0	0	9	0	0
10	0	0	0	10	0	0	10	0	0	10	0	0
11	0	0	0	11	0	0	11	0	0	11	0	0
12	0	0	0	12	0	0	12	0	0	12	0	0

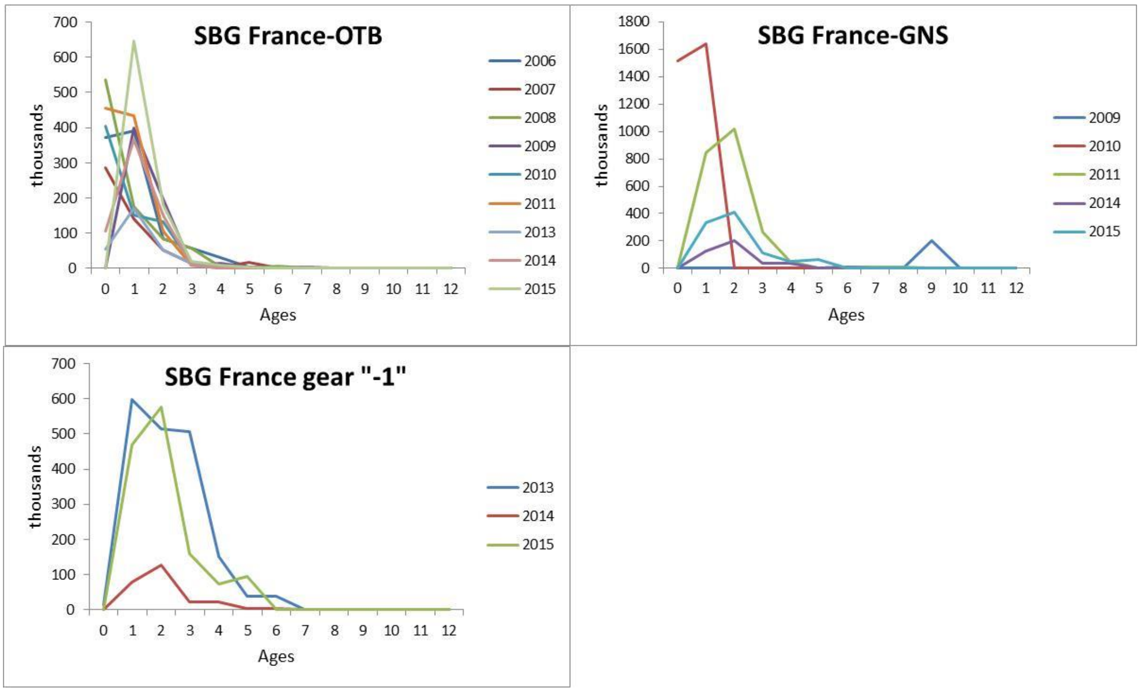

Figure 6.17.1.2.3. Gilthead seabream in GSA 7. Age structure of the main fishing gears, OTB-France and GNS-France; and the age structure of the non-identified fishing gear "-1". Note the different scale of y-axis.

Spain- no age data for GNS, GTR, LLS, OTB

DISCARDS

There is no data on gilthead seabream discards in GSA 7.

6.17.1.3 Fishing effort data

Fishing effort data from DCF France are available only for 2015, while information is available for the Spanish fleets over 2004-2015. Nevertheless, the gilthead seabream landings of the Spanish fleets are very low and the French fleet represents 97% of the total effort in GSA7. Additional information on the French fleets was submitted while EWG16-17 was taking place. Finally, information is available for French fishing effort in GSA 7 for the period 2012-2015.

The total fishing effort (GT*days at sea) in GSA 7 by year is shown Table 6.17.1.3.1 and Figure 6.17.1.3.1.

Table 6.17.1.3.1. Total fishing effort (GT*days at sea) in GSA 7, by year.

	ESP	FRA	ESP+FRA	%FRA
2004	376298			
2005	351062			
2006	337666			
2007	348066			
2008	350818			
2009	324513			
2010	297675			
2011	334699			
2012	284196	426551	710747	60.0
2013	265596	1069415	1335011	80.1
2014	282866	1223963	1506829	81.2
2015	289331	10841830	11131161	97.4

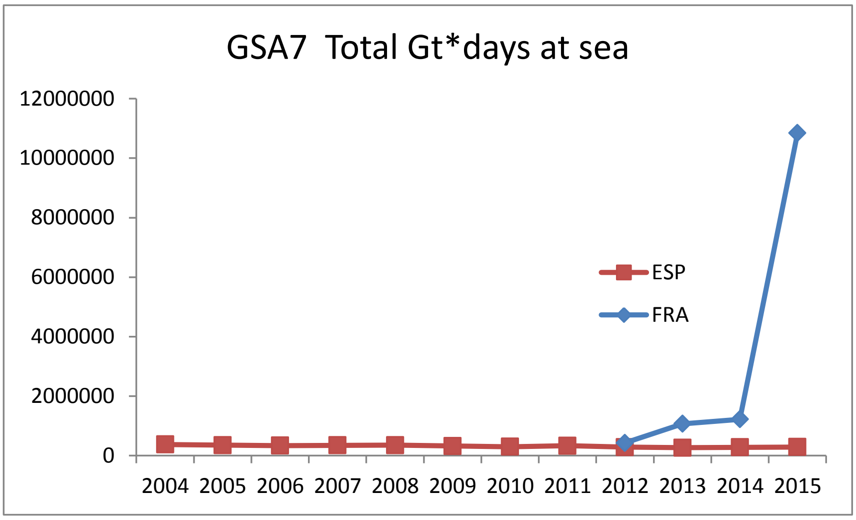

Figure 6.17.1.3.1. Total fishing effort (GT*days at sea) in GSA 7, by year.

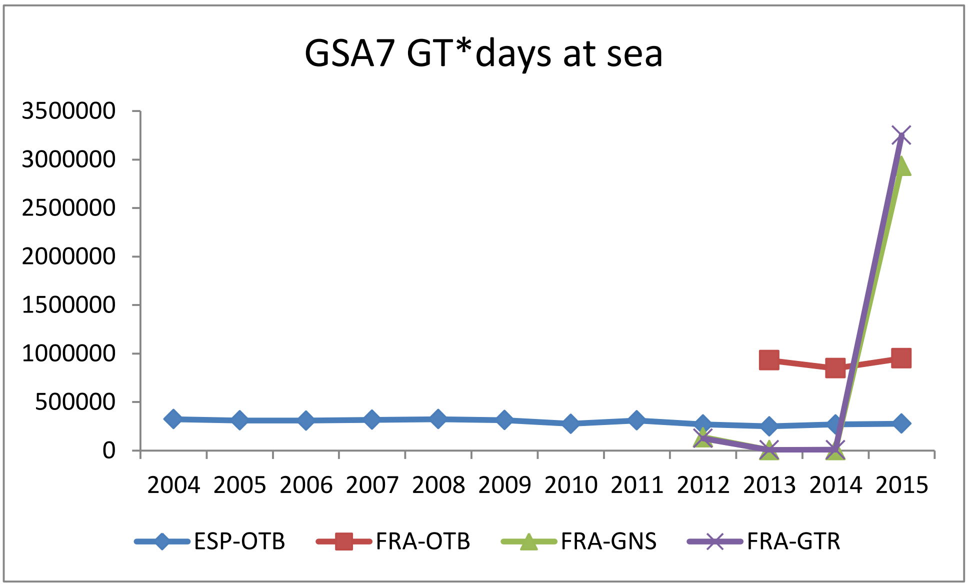

Figure 6.17.1.3.2. Fishing effort (GT*days at sea) in GSA 7 for the main fishing gears targeting gilthead seabream.

Table 6.17.1.3.2. Fishing effort in GSA 7, France 2015, GT*days at sea and days at sea.

GSA 7. Fishing effort: GT*days at sea/fishing gear/year, France		GSA 7. Fishing effort: days at sea/fishing gear/year, France	
gear	2015	gear	2015
-1	1315223.0	-1	20443
DRB	57573.4	DRB	566
FPO	790800.0	FPO	6682
FYK	370289.8	FYK	10551
GND	21549.9	GND	141
GNS	2934287.1	GNS	36188
GTR	3250502.6	GTR	43299
LHP	130844.9	LHP	2052
LLD	378627.8	LLD	2449
LLS	392031.5	LLS	5202
LTL	2911.8	LTL	47
OTB	949262.2	OTB	9939
OTM	55063.3	OTM	386
OTT	78788.5	OTT	736
PS	105784.5	PS	883
SB	8289.7	SB	178
Total	10841829.9	Total	139743

Table 6.17.1.3.3. Fishing effort (GT*days at sea) in GSA 7 for the main fishing gears targeting gilthead seabream.

	ESP-OTB	FRA- OTB	FRA-GNS	FRA-GTR
2004	322841			
2005	308926			
2006	308266			
2007	316488			
2008	322027			
2009	313450			
2010	275498			
2011	310191			
2012	268789		135974	124726
2013	248107	929623	4809	5224
2014	268090	847587	4397	7630
2015	276490	949262	2934287	3250503

A large variety of fishing gears are used in GSA 7 (Table 6.17.1.3.2), although most of the gilthead seabream catch comes from OTB, GNS and GTR. Table 6.17.1.3.3 shows the available information to EWG16-17 on these gears.

Taking into account that the information on the fishing effort corresponding to the French fleets is very limited and that the French fishing effort values in 2015 are very different from the previous years, valid fishing effort trend cannot be provided for GSA 7.

6.17.1.4 Survey Indices of abundance and biomass by year and size/age

The available information on *Sparus aurata* in GSA 7 from MEDITS surveys is shown in Table 6.17.1.4.1.

Table 6.17.1.4.1. Gilthead seabream in GSA 7. MEDITS data, total weight and number by year.

year	total weight (kg)	total number
1998	1.33	4
2000	0.34	1
2008	1.10	4
2010	9.93	15
2012	2.32	9
2013	0.52	2
2014	0.92	4
2015	0.16	1

6.17.2 STOCK ASSESSMENT ON GILTHEAD SEABREAM IN GSA 7

Method 1- Pseudo- cohort analysis

Gilthead seabream is fished by a large variety of fishing gears. Among them, GNS, GTR and OTB from France take most of the catch. Data on the size structure of these gears was available for 2013-2015, and complete information on the size structure of all gears was available only for 2015 (Tables

6.17.1.2.2 and 6.17.1.2.4). For this reason, pseudo-cohort analyses (VIT; Lleonart and Salat 1992) for years 2013, 2014 and 2015 were performed using as input the size structure of only GNS, GTR and OTB. The results from these analyses were compared to those obtained in 2015 using as input the size structure from all available 14 fishing gears. In 2015, the catch of an unknown fishing gear "-1" was reported to be around 30% of the annual gilthead seabream catch. The size structure of this gear was similar to that of GNS and GTR combined, though information on its identity could not be ascertained, and in 2015 the four gears more closely matched the proportion of catch by the three recognised gears (Table 6.17.2.1) therefore the data was included as part of the fishery for 2015 .

Table 6.17.2.1. Gilthead seabream in GSA 7. Percentage of the gilthead seabream catches corresponding to OTB, GNS, GTR and "-1" in the period 2013-2015.

	-1	OTB	GNS	GTR	total	% 3 gears
2013		66.21	526.37	108.58	907.02	77.3
2014		134.48	182.23	169.92	683.44	71.2
2015		154.27	387.40	376.06	1697.90	54.1
	-1	OTB	GNS	GTR	total	% 4 gears
2015	545.491	154.27	387.40	376.06	1697.90	86.2

The input parameters were the following:

Growth parameters

The set of growth parameters used was that proposed by Campillo 1992 (Table 6.17.1.1.1) for both sexes combined (Linf=75.97, k=0.13, t_0=-1.22; length-weight relationship: a=0.0112, b=3.08). The DCF parameters were not used because the very negative t_0 led to computing errors (negatives ages).

Maturity ogive used was that proposed in the DCF (Fig.6.17.1.1.2).

Natural mortality vector (estimated with the method proposed by Gislason *et al*. 2010)

ages	0	1	2	3	4	5	6+
M Gislason	1.48	0.78	0.52	0.39	0.32	0.27	0.23

Numbers at age for the catch were estimated transforming the annual size distributions of the landings to ages using VIT software. It is worth noting the very similar mean length and mean age of the OTB+GTR+GNT catch to that in 2015 resulting from the catch of the fourteen gears combined.

Table 6.17.2.2. Gilthead seabream in GSA 7. Catch at age matrix, by year and fishing gear (gear1=OTB, gear2=GNS, gear3=GTR).

Catch in Numbers		2013		
	Total catch	Catch of gear 1	Catch of gear 2	Catch of gear 3
0	209232.8	209232.8	0.0	0.0
1	432735.8	223178.1	205663.7	3894.1
2	983544.2	92570.3	775751.5	115222.4
3	419468.3	10418.2	340602.7	68447.4

4	141853.1	2930.1	112893.1	26029.9
5	30728.8	2007.7	23969.4	4751.7
6+	30696.7	1302.3	18199.0	11195.4
Total	2248259.7	541639.5	1477079.4	229540.8
Mean Age	2.5	1.3	2.8	3.2
Mean Length	28.3	20.6	30.3	32.8

Catch in Numbers		2014		
	Total catch	Catch of gear 1	Catch of gear 2	Catch of gear 3
0	87777.2	87258.8	518.5	0.0
1	767718.5	583216.6	125856.9	58645.0
2	992169.8	247512.8	372062.1	372595.0
3	211954.2	11839.6	104859.2	95255.4
4	56297.2	839.0	27673.0	27785.2
5	10880.9	839.0	4860.6	5181.3
6+	11991.6	0.0	5443.9	6547.7
Total	2138789.4	931505.8	641274.0	566009.5
Mean Age	2.2	1.6	2.5	2.6
Mean Length	26.7	23.4	28.9	29.7

Catch in Numbers		2015		
	Total catch	Catch of gear 1	Catch of gear 2	Catch of gear 3
0	247715.1	240596.5	0.0	7118.7
1	1939378.5	875503.8	558448.6	505426.1
2	1917803.6	328518.1	769391.7	819893.7
3	493202.9	30594.4	154013.9	308594.7
4	220705.9	6386.2	105048.0	109271.7
5	78415.4	2079.2	56759.8	19576.4
6+	55798.6	594.1	45238.4	9966.2
Total	4953020.0	1484272.2	1688900.4	1779847.4
Mean Age	2.2	1.5	2.5	2.5
Mean Length	26.8	22.6	28.7	28.6

Table 6.17.2.3. Gilthead seabream in GSA 7. Catch at age matrix by year and fishing gear (gear1=OTB, gear2=GNS, gear3=GTR; cont.).

Class	Total catch	2015 all gears
0	133178.9	
1	1445877.1	
2	2092226.5	
3	520897.6	
4	193177.6	
5	75907.4	

6+	71362.1
Total	4532627.12
Mean Age	2.4
Mean Length	27.8

Because of the very wide variations of F in the older ages, a sensitivity analysis was done performing VIT with different Ft (0.2 to 0.7, step 0.1) and different age+ groups. The final analyses were done with Ft=0.4 and age 6+. Yield per recruitment analyses was done based on VIT pseudo-cohort analyses results to estimate the $F_{0.1}$ (i.e. proxy of F_{MSY}).

Table 6.17.2.4. Gilthead seabream in GSA 7. Pseudo-cohort analyses results, stock numbers at age and F at age.

Numbers				
Class	2013	2014	2015	2015-all gears
0	29966155.6	23596416.8	57568385.3	57118428.0
1	6730305.2	5332434.7	12996787.3	12944245.3
2	2801288.9	1937193.4	4696781.0	4989705.9
3	933789.0	420995.1	1373471.0	1420298.8
4	297402.0	115855.8	533772.3	543438.5
5	98056.2	37190.7	203473.1	232966.5
6+	48347.3	18952.9	87882.8	112395.2
F				
Class	2013	2014	2015	2015-all gears
0	0.01	0.01	0.01	0.00
1	0.10	0.23	0.24	0.17
2	0.58	1.01	0.71	0.74
3	0.75	0.90	0.56	0.57
4	0.79	0.82	0.64	0.53
5	0.44	0.40	0.57	0.46
6+	0.40	0.40	0.40	0.40

Table 6.17.2.5. Gilthead seabream in GSA 7. Pseudo-cohort analyses summary results.

	OTB+GNT+GTR			ALL GEARS
	2013	2014	2015	2015
Landings (t)	907.02	683.437	1697.9	1697.9
R(thousands)	29966155.6	23596416.8	57568385.3	57118428.0
Btotal(t)	2808.9	1826.3	5003.1	5164.8
SSB (t)	1586.8	860.8	2648.7	2824.1
F	0.44	0.54	0.45	0.41
F(1-3)	0.48	0.71	0.50	0.49
F(0.1)-factor	0.38	0.33	0.37	0.39

The summary results of the pseudo-cohort analyses are presented in tables 6.17.2.3 and 6.17.2.4. In principle, the results from the most recent year and with most complete information (i.e. 2015-all gears) would be those that best reflect the status of the gilthead seabream fishery in the Gulf of Lions. The pseudo-cohort analyses results in 2013-2015 using as input the data from OTB, GTN and GTR allows comparison with the results in 2015 using the data from all gears with gilthead seabream catch. Since in 2015 gilthead seabream reported landings were much higher than those the previous years, recruitment (R), total biomass (Btotal) and spawning stock biomass (SSB) were also much higher in 2015 than in the previous years, while F oscillated between 0.4 and 0.5. $F_{0.1}$ was similar in all cases, ranging from 0.33 to 0.39.

Figure 6.17.2.1 show the Y/R results. The figure indicates signs of over-exploitation.

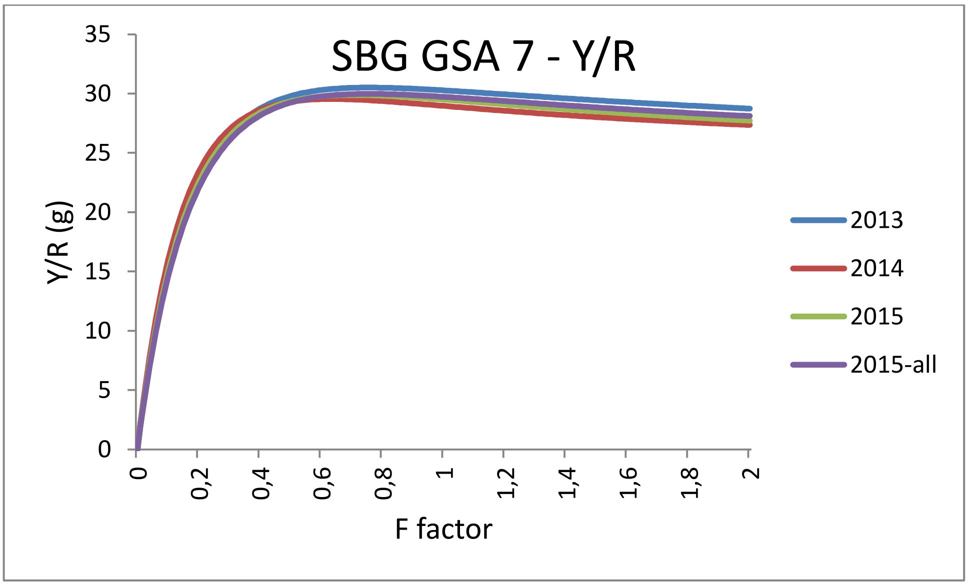

Figure 6.17.2.1. Gilthead seabream in GSA 7. Yield per Recruit analysis.

Method 2- Length indicators analysis

Length based indicators based on those reported in ICES WKLIFE V (2015) were calculated for the stocks and GSAs of interest. Only *Lmean* relative to *LFeM* (*Lmean/LfeM*) was used in the final analysis. It can be used as an indicator of FMSY and is recommended to be >= 1, i.e. a value < 1 suggests overfishing.

Figs. 6.17.2.2 and 6.17.2.3 show the input data and results of the length indicators analysis.

Results, indicator with values< 1, suggest a situation of overfishing for gilthead seabream in GSA 7, as observed in the pseudo-cohort and Y/R analyses. Linf was taken to be 76 cm.

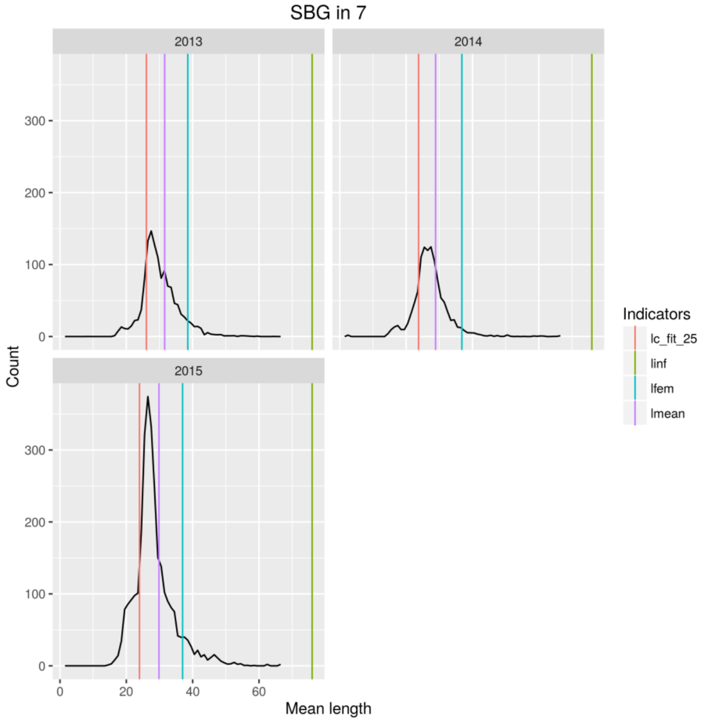

Figure 6.17.2.2. Gilthead seabream in GSA 7. Input data for the length indicators analysis, showing the size structure and the different length values used in the analysis.

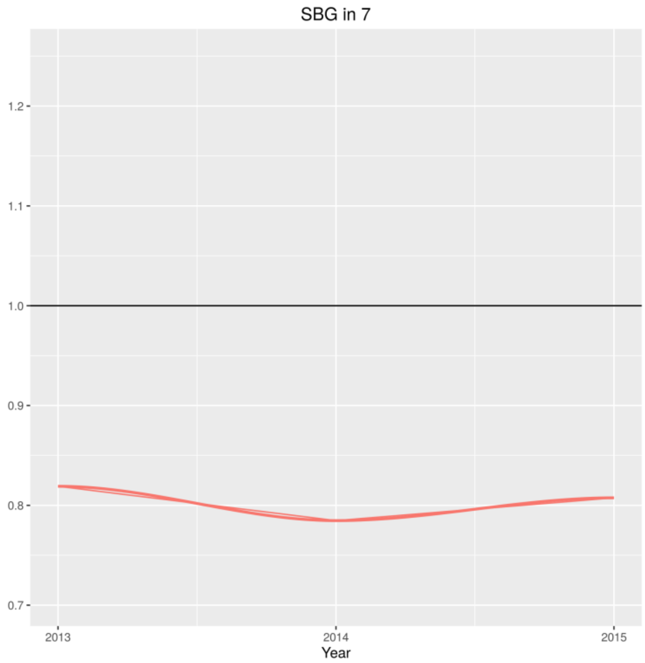

Figure 6.17.2.3. Gilthead seabream in GSA 7. Results of the length indicator analysis, showing a situation of over-fishing.

The overall perception from length-based indicators is that the stock is being fished well above MSY level. This supports the view of the VIT assessment. There is no real indication of significant change in exploitation over the four years available. The overall coherence of the results supports the conclusion that the stock is being fished well above FMSY.

6.17.3 REFERENCE POINT

Assuming that the pseudo-cohort analysis based on the most recent data (2015), which included the size structure of all fishing gears with reported gilthead catch, and taking $F_{0.1}$ as proxy for F_{MSY} (see Table 6.17.2.4), the reference point would be $F_{(0.1\text{-factor})}$ = 0.4, which corresponds to F=0.2.

Table 6.17.3.1. Gilthead seabream in GSA 7 reference point based in the Y/R analysis.

		F(0.1) factor	F(F0.1)
Fmean	0.41	0.39	0.16
F(1-3)	0.49	0.39	0.19

6.17.4 SHORT TERM FORECAST

No short term forecasts were performed for gilthead seabream in GSA 7.

6.17.5 QUALITY AND PROPOSALS FOR FUTURE ASSESSMENTS

No information is available for gilthead seabream from surveys.

Due to data limitation, the pseudo-cohort analysis was the methodology that was chosen to assess the stock status of gilthead sea-bream. In the near future it will not be possible to perform VPA since only for the last years information on the size structure of the catches was available for the fishing gears dominant in the landings, and only for 2015 this information was available for all the fishing gears with gilthead seabream reported catch, and, furthermore, no information is available from surveys.

7 Data quality check

ToR 6: Summarize and concisely describe all data quality deficiencies, including possible limitations with the surveys of relevance for stock assessments and fisheries. Such review and description are to be based on the data format of the official DCF data call for the Mediterranean Sea launched on the 28 April 2016. Identify further research studies and data collections which would be required for improved fish stock assessments.

7.1 EUROPEAN SEABASS IN GSA 7

Part of the information on effort from France were requested and arrived to the EWG, but such information has shown unreliable numbers, which were useless

7.2 EUROPEAN SEABASS IN GSAs 1,5,6 AND 7

See section 7.1

7.3 ANGLERFISH IN GSA 6

See section 7.5

7.4 ANGLERFISH IN GSA 7

See section 7.5

7.5 ANGLERFISH IN GSAs 1,5,6 AND 7

Data from DCF 2016 were used. The data submitted to the EWG 16-17 for L. piscatorius are of sufficient quality to perform a VPA on pseudocohorts at an annual scale for the years 2013-2015, but incomplete to perform a tuned VPA due to the missing of data from the French fleet until 2013 and the low quality of the size distribution for some years at the beginning of the time series. This is the first attempt to assess the species and thus must be considered as provisional.

7.6 STRIPED RED MULLET IN GSA 9

Older ages were poorly presented. It was dealt with in the way of aggregating in plus group. Also retrospectives has not been ideal but it was good enough to run the assessment.

7.7 STRIPED RED MULLET IN GSA 11

No comment

7.8 NORWAY LOBSTER IN GSA 6

The main data quality deficiency observed in N. norvegicus in GSA 6 was the mismatch between the trends of landings and MEDITS indices, which hindered the production of a reliable XSA assessment. The dramatic drop of the MEDITS abundance and biomass indices in 2014 and 2015 was not observed in the landings. Therefore, the MEDITS data of 2014 and 2015 need to be revisited to assess whether the observed drop was an artefact or a real reduction which for some reason was not observed in the landings. MEDITS data of earlier years (especially 2009, 2012 and 2013) also exhibit some consistent discrepancies with landings.

It was noted that some entries in the MEDITS LFD data were in milimeters instead of centimeters and need to be corrected. These erroneous entries were (by entry id): 3407785-89, 3436154, 3446194-95, 3503235 and 3580944.

MEDITS LFDs of year 2001 had a different range in the length classes compared to the other years (5 mm instead of 1 mm). This discrepancy did not affect the assessments, as these were carried out for 2009-2015.

No data on growth, maturity and sex ratio were available in the DCF for N. norvegicus in GSA 6. These should be collected and reported in the future.

Male and female specimens of N. norvegicus are known to exhibit different growth patterns. Hence, the provision of sex ratios by length and year in the catches, would allow more accurate assessments in the future, based splits by sexe.

7.9 NORWAY LOBSTER IN GSA 9

Data from EU DCF as submitted through the Official data call in 2016 were used. For age distributions of landing and discard DCF available at the STCF EWG 14-09, it is not possible to know which growth parameters have been applied. For length frequency distributions, data are available for sex combined. For species like Norway lobster where growth rates are different by sex, it would be useful to have separate data by sex. Number of individuals at length by metier were missing to OTB DEMSP (2005) and OTB DWSP for several years between 2008 and 2015. In these cases raising factors were applied.

7.10 NORWAY LOBSTER IN GSA 11

Data on growth parameters of *N. norvegicus* in GSA 11 were only available for males and pertain to a long unic period (2005-2015). While it is well know that male and female exhibit different growth patterns, the provision of growth parameters by sex and shorter time periods, the sex ratios by length and year in the catches, would allow to carry out more accurate assessments in the future.

7.11 NORWAY LOBSTER IN GSAs 17 AND 18

EU DCF landings data prior to 2006 were not available for GSA 17 ITA. Data from Croatia (GSA 17) were available for 2013-2015 only. Discards data in GSA 17 ITA were available only for 2011. MEDITS data before 2002 were not available for GSA 17.

7.12 DEEP-WATER ROSE SHRIMP IN GSA 1

Data from EU DCF as submitted through the official data call in 2016 were used. Length-frequencies distributions (LFD) were missing for the "métier" OTB_DWS. Missing LFD were borrowed from other OTB segments. Catches age structure was also missing in the database.
Biological parameters (growth parameters, sex-ratio) were not furnished for this species in GSA 01.

7.13 DEEP-WATER ROSE SHRIMP IN GSA 9

Data from EU DCF as submitted through the Official data call in 2016 were used. Length-frequencies distributions (LFD) were missing for the "métier" OTB_DWS. Missing LFD were borrowed from other OTB segments. EU DCF data prior to 2006 were considered incomplete; therefore, they were not used for the stock assessment.
Discards data were missing for 2007 and 2008 as their collection was not compulsory. Discards for OTB those two years were estimated as the mean discard of the entire time-series. The LFD of OTB discards of 2009 were used to raise the discards.
One set of biological parameters (growth parameters, sex-ratio) has been furnished for the period 2006-2015.

7.14 DEEP-WATER ROSE SHRIMP IN GSA 10

Data from DCF 2016 were used. A difference in the sum of products compared to landings was always far less than 10%. Discards data of 2006 and 2009 to 2015 were available. Information on number of samples for landings, discards and catches, as well as the number of measurements by length for landings, discards and catches were also available. MEDITS raw data used for this assessment have been processed by the expert using the software FishTrawl. Growth, maturity by length and age and sex ratio were available for the whole time series (2002-2015).

7.15 DEEP-WATER ROSE SHRIMP IN GSAs 9,10, AND 11

Data from EU DCF as submitted through the Official data call in 2016 were used. The time series of the demographic structures of landing were different according to the three GSAs: 2003-2015 for GSA 11, 2006-2015 for GSA 09 and 2009-2015 for GSA 11. Due to those differences, the analyses were carried out on the period 2006-2015. An extrapolation of the data for the years 2006-2008 has been made for GSA 11, taking into account that the landing of deep-water rose shrimp in this area has a low weight in comparison to the other two GSAs.
Discards data in GSAs 09 and 10 were missing for 2007 and 2008 as their collection was not compulsory. Data available in the other years were used to raise the lacking ones (see

methodology in the single assessments of the two GSAs). Discard was not available for GSA 11; however, this fraction was considered negligible.
One combined set of growth parameters has been furnished for GSA 11. This could affect the slicing of the length frequency distributions of the catches and MEDITS data as the species is characterised by significant differences in the growth rates between the two sexes.

7.16 COMMON SOLE IN GSA 7

1.- There are not biological parameters defined for Common sole GSA 7 in DCF: no growth parameters, no length-weight relationship, no maturity data, no sex-ratio, etc. There are parameters for other Mediterranean GSA's but it would be necessary biological parameters for this species in GSA 7.

2.- French landings data are available for a short period, 2011-2015, gear separately. It would be necessary to have a complete landing series at least for the main gears that catch Common sole (OTB, GNS, GTR). 2012 landings data are missing for the main gear, GTR. No data about discards.

3.- French length-frequencies are only available for the three main gears (OTB, GNS, GTR) in years: 2011, 2013, 2014 and 2015. 2012 OTB length frequency is unreliable. Spanish length frequencies in GSA 7 are only available for OTB 2009 and 2010. There are not age frequencies in DCF.

4.- French Effort data series in GSA 7 is limited to 2015 in DCF. During the EWG 16-17 has been submitted an additional series of French effort. Finally it has been available French effort data in GSA 7, gear separately, for the period 2013, 2014 and 2015. It is required a longer series of French effort data in GSA 7.

5.- Data surveys doesn't cover adequately this species. MEDITS surveys catch Common sole occasionally and there is not possible to calculate abundance and biomass indices for Common sole in GSA 7

7.17 GILTHEAD SEABREAM IN GSA 7

No data is available on discards.
Data on the landings size structure of all the fishing gears with reported gilthead seabream is available for 2015.
Effort data from the French fleets appears to be updated only for 2015.
MEDITS surveys report very occasional catch of gilthead seabream, and thus, it is not possible to know the species trend on abundance or biomass in GSA 7.
The identification of the fishing areas should be unique e.g. the Gulf of Lions area is identified by "GSA 7" and "SA 7", which may lead to incomplete selection of data. This failure affects a number of GSAs.
In the files corresponding to catches, landings and discards, often "quarter" is not specified (value "-1"), and thus, the information on the seasonality of landings is lost.
Code "-1" has been used for an unidentified fishing gear of the French fleets, with high gilthead seabream landings in 2015.
Growth parameters should be updated; t0 is very negative. In addition, since gilthead seabream is a protandrous hermaphrodite, with marked differences in growth by sex, it would be advisable to estimate growth parameters by sex.

8 General Data submission Issues

MEDITS 1994-2001 in GSA 17 has never been submitted by Italy and Croatia, this is a recurrent gap that undermine any demersal stock assessment involving GSA 17.

9 Stock Specific Data Issues

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11 CONTACT DETAILS OF EWG-16-17 participants

[1] - Information on EWG participant's affiliations is displayed for information only. In any case, Members of the STECF, invited experts, and JRC experts shall act independently. In the context of the STECF work, the committee members and other experts do not represent the institutions/bodies they are affiliated to in their daily jobs. STECF members and experts also declare at each meeting of the STECF and of its Expert Working Groups any specific interest which might be considered prejudicial to their independence in relation to specific items on the agenda. These declarations are displayed on the public meeting's website if experts explicitly authorized the JRC to do so in accordance with EU legislation on the protection of personnel data. For more information: http://stecf.jrc.ec.europa.eu/adm-declarations

STECF members			
Name	**Address**	**Tel.**	Email
Abella, J. Alvaro	Independent consultant	Tel. 0039-3384989821	aabellafisheries@gmail.com
Martin, Paloma	CSIC Instituto de Ciencias del Mar PasseigMarítim, 37-49 08003 Barcelona Spain	Tel: 34.93.2309500 direct line : 34.93.2309552 Fax: 34.93.2309555	paloma@icm.csic.es

Invited experts			
Name	**Address**	**Tel.**	Email
John Simmonds (Chair)	Private Consultant, Netherby - West End - Kirkbymoorside, YO62 6AD North Yorkshire, United Kingdom		e.j.simmonds1@gmail.com
Vanja Cikes Kec	Institute of oceanography and fisheries. Croatia		cikes@izor.hr
Francesco Colloca	CONSIGLIO NAZIONALE DELLE RICERCHE - ISTITUTO AMBIENTE MARINO COSTIERO		francesco.colloca@iamc.cnr.it
Maria-Teresa Facchini	COISPA – Tecnologia e Ricerca. Bari. Italy		facchini@coispa.it
Alexandros Kokkalis	DTU Aqua - National Institute of Aquatic Resources		alko@aqua.dtu.dk
Matteo Murenu	Università di Cagliari - DBAE		mmurenu@unica.it
Claudia Musumeci	Centro Intruniversitario di Biologia Marina Viale Nazario Sauro 4 57128 Livorno, Italy		clamusu@gmail.com
Francesco Ordinas	Instituto Español de Oceanografía. Spain		xisco.ordinas@ba.ieo.es
John Ramirez	Institute of Marine Sciences of Barcelona ICM-CSIC.Spain		j.gabriel@icm.csic.es

Laura Recasens	Institut Ciències Mar Barcelona (ICM-CSIC).Spain		laura@icm.csic.es
Mariano Garcia Rodriguez	Instituto Español de Oceanografía.Spain		mariano.garcia@md.ieo.es
Sbrana, Mario	Centro Intruniversitario di Biologia Marina Viale Nazario Sauro 4 57128 Livorno, Italy	Tel.+390586260723 Fax+390586260723	msbrana@cibm.it
Vasilakopoulos, Paraskevas	Hellenic Centre for Marine Research 46.7km Athens-Sounio ave. 19013 ANAVYSSOS; ATTIKI Greece	+30 210 9856703	pvasilakopoulos@hcmr.gr
Barbara Zorica	Institute of oceanography and fisheries.Croatia		zorica@izor.hr

JRC experts

Name	Address	Telephone no.	Email
Osio, Giacomo Chato	Joint Research Centre (IPSC) Maritime Affairs Unit Via E. Fermi, 2749 21027 Ispra (Varese), Italy	Tel.+390332785948 Fax+390332789658	giacomo-chato.osio@jrc.ec.europa.eu
Scott, Finlay	Joint Research Centre (IPSC) Maritime Affairs Unit Via E. Fermi, 2749 21027 Ispra (Varese), Italy	Tel.+39 0332789677 Fax+39 0332789658	Finlay.Scott@jrc.ec.europa.eu
Mannini, Alessandro	Joint Research Centre (IPSC) Maritime Affairs Unit Via E. Fermi, 2749 21027 Ispra (Varese), Italy	Tel.+390332785948 Fax+390332789658	alessandro.mannini@jrc.ec.europa.eu

European Commission

Name	Address	Telephone no.	Email
Osio, Giacomo Chato	DG Joint Research Centre JRC, STECF secretariat		Stecf-secretariat@jrc.ec.europa.eu

12 List of Background Documents

Background documents are published on the meeting's web site on:
http://stecf.jrc.ec.europa.eu/web/stecf/ewg1617

List of background documents:

1. STECF EWG 16 17_Declarations of interests (see also section 11 of this report – List of participants).pdf

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